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The Effects of a Scale-Down in Defense Budgets

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ORGANIZATION OF THE PROJECT

Given the broad scope of the project and the diversity of the material to be presented, it was decided to organize its output into three volumes.

Volume I is focussed on an investigation of the business operations of a number of United States and German firms involved in the production of their respective main battle tanks; the M-1 Abrams and the Leopard-2. The key concern motivating the work that comprises this volume was on determining the impact on both American and German firms of continuing reductions in the defense budgets of each of the respective nations. Given the inherent breadth and complexity of this issue, it was decided early on that the initial research should be based on the analysis of the industrial organization used to produce a specific weapon system. Because of the relative size, complexity, and military comparability of the Abrams and Leopard-2 tanks, this weapon system was selected.

Having made this selection, and in keeping the overall breadth of this project, a series of decisions on the appropriate research methodologies to be used in the project were then made. The rationale for each of these methodological decisions is discussed in summary form in Chapter One. Of particular importance here was the decision to take a micro-economic or firm-specific approach to the data gathering and analysis phase of the study and, collaterally, to not rely on macro-economic analyses except where absolutely necessary.

The first of the substantive discussions on the scale-down of the U.S. defense budget is then presented in Chapter Two. Information on prior mobilization and scale-down periods, and the post-Viet Nam era in particular, is presented and analyzed. Particularly important here for its effect on the U.S. defense industrial base is the potential difference in economic conditions between the post-Viet Nam era and those that are likely to obtain in the 1990s.

Chapter Three then presents the data and information gathered during a series of field trips to a number of the U.S. firms involved in the production of the Abrams tank. The problems of scale-down and reconstitution is discussed in this chapter as a preliminary to the conclusions presented in Chapter Four on the type of research methodologies needed for more sophisticated research on the scale-down and reconstitution problem as it affects the U.S. defense industrial base. The suggestion here is for "force multiplier" and "product line" research.

This is followed in Chapter Five by the report on the site visits made by the Kiel Weltwirtschaftsinstitut team to a number of German manufacturing firms involved in the production of the Leopard-2 tank. Where possible, the data is presented in a form similar to that found in Chapter Three, along with relevant conclusions on the scale-down and reconstitution problem as it is found in Germany. An analysis of the comparative "robustness" of the German defense industrial base is then presented in Chapter Six.

Volume II is an extremely broad-based discussion of the institutional factors displayed in the matrix presented in the Introduction of *Volume I*. As such, this volume provides a series of detailed discussions on a number of the institutional factors found in the German "system" and how they interact to create the current organization and operation of the German economy.

Volume III is the complete report provided by the staff at the Kiel Weltwirtschaft. This report covers not only the site visits presented in Chapter Five of **Volume I**, but a number of supporting analyses on the German defense industrial base, the German educational system, merger policy in Germany, and more recent legislation controlling the export of military equipment and “dual-use” technologies.

FOREWORD

This report can be used as testimony for international cooperation in education and research. The foundation for this cooperation was built in November 1988 with the signing of an International Defense Education Agreement (IDEA) by:

- The Commandant of the Defense Systems Management College (DSMC) - U.S.,
- The Commandant of the Royal Military College of Science (RMCS) - G.B., and
- The President of the Academy for Defense Administration and Technology (ADAT) - Germany.

Experiences gained from and opportunities provided by IDEA resulted in a Memorandum of Agreement (MOA) between DSMC and ADAT in September 1991. This MOA extended the IDEA to include a specific research topic of common interest: The comparable effects of a scale-down of Defense Budgets in the U.S. and Germany.

Planning meetings between the Commandant, DSMC, the President of ADAT and their staffs resulted in decisions:

- to conduct a “pilot-study” to learn what knowledge and data-nodes are needed for the study and the development of a research methodology,
- to concentrate on the cultural-economic-legal drivers behind the differences (if any),
- to use the U.S. Abrams tank and the German Leopard-2 tank as “comparable objects” for the pilot study to find meaningful comparable data and information, and
- to use the U.S. part of the comparative study as the lead part, accepting some time slippage from the original plan.

The DSMC selected Georgetown University (GTU) and the ADAT selected the Institute for World Economy (IWE) at the University Kiel (Germany) as their study partners.

Ready for action, GTU and IWE reported on data and information research with unrestricted support from the U.S. Army Materiel Command and the German Ministry of Defense. Without this enthusiastic support, the study would have failed.

The joint effort by DSMC, GTU, IWE and ADAT and the results are documented in the present volume.

My thanks to all who supported this study. I regret that the late Professor David D. Acker, who started this project with Professor Franz Frisch, cannot enjoy the results.

I recommend this document as a guideline for other comparability studies; but foremost to deepen the mutual understanding among NATO partners. Comments regarding this study may be referred to:

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INTRODUCTION

The Initial Basis for this Project

The initial goal of this project was to develop a preliminary analysis of the impact on the U.S. defense industrial base of relatively deep and continuing reductions in the defense budget.

Two issues were of central concern:

1. How the U.S. defense industrial base will reorganize itself in light of the limited sales volume that will be available to it in the foreseeable future.
2. Having "down-sized" itself, whether the U.S. defense industrial base will be able in the future to meet an emergent major military threat of major proportions.

Because the politico-economic environment of the 1990s is apt to be substantially different than that of other periods when there was a significant down-turn in the level of U.S. defense expenditures, it was decided to classify this study as being "exploratory" in scope and content. By exploratory, we mean that the project staff was given the mandate to cast a rather wide net intellectually, and not adhere to any prescribed research methodology. As such, the research team was given *carte blanche* to investigate any area of interest that it deemed relevant to the successful completion of the research project.

However, as a modification to the initial goals of the project, it was decided that the output of the study would be more valuable to its various audiences if the research was broadened to include a comparative analysis of the down-sizing process in an allied European nation. For these purposes, Germany was selected as the basis for a European-based analysis to be conducted by staff economists from the *Weltwirtschaftsinstitut* in Kiel.

The choice of Germany as the comparative unit was purposeful and is based on the close working relationship between the Defense Systems Management College of the U.S. Department of Defense and the *Bundeskademie für Wehrverwaltung und Wehrtechnologie* in Mannheim. These two military acquisition-oriented institutions have had a long history of successful cooperation in defense acquisition matters and were eager to participate in a joint study of this nature.

Expanding the Project: The German Experience

Early on in the project, it became evident that a number of additional factors had to be included in the research effort were it to be meaningful to its various sponsors.

First, it became evident that a direct comparison of U.S. to German industrial structure would be meaningless unless the U.S. team developed a more comprehensive understanding of the various political, social and economic factors that are the driving force behind German industrial structure. Here it was recognized that Germany is different than the United States albeit in ways that are not evident to most Americans. For a number of reasons, the American academic community has paid little attention to the post-World War II redevelopment of the German economy such that relatively few Americans have a reasonably comprehensive view of how the country is organized. Moreover,

the business-based academic community in the United States has to date ignored the structure and operations of the German industrial sector.¹

One can posit a number of reasons for this. One, given the geographical isolation of their country, Americans tend to be ethnocentric. Two, the American media have paid far greater attention to the "Japanese threat" to American economic strength than they have to other equally pervasive factors. Three, until recently, the American business-based academic community has not felt that there was much that could be learned from any analyses of the structure and operations of German economy. Given the United States' preoccupation with Japan, the academic community had forgotten that Europe is by far the largest economic unit in the world. Lastly, there is a residual degree of antipathy in the American academic community vis-a-vis Germany given the history of the past two world wars.

For all of these reasons, it was then decided that the research team should develop as broad-gauged an understanding of Germany as was possible given time and budget limitations.

A Focus on Institutional Factors in Germany

Given this broad a mandate, two key decisions were made with respect to research methodology and what we must now term "perspective."

Methodologically, it was decided that the research should focus on developing a better understanding of the history and current operations of the various institutions that make up the German system. By institutions, we mean here such factors as:

- 1. The structure and operations of the German banking system.**
- 2. The legislative mandate and operations of the Bundesbank.**
- 3. The organization and operations of the German stock market.**
- 4. Corporate structure in Germany and, in particular, the governance process of the German corporation.**
- 5. The role of labor in the Germany economy with special attention paid to such factors as "Mitbestimmung" and other stakeholder concepts.²**
- 6. The position, organization and operations of the "mittelstandische Industrie" in the overall German economy.³**

1 With the exception of an occasional short article in the business press, little attention has been paid to the organization and operations of the German industrial sector by American authors. In 1992, however, a number of articles explaining the German perspective in adequate detail appeared in the *Harvard Business Review*. See, for example, Herbert Simon, "Lessons from Germany's Mid-size Giants", Mar-Apr 1992, and Herbert A. Henzler, "The New Era of Eurocapitalism", July-Aug 1992.

2 The term "Mitbestimmung" is most normally translated as co-determination. Under the terms of the co-determination legislation, among the rights granted to the employees of a business is the right to appoint 1/3 or more of the members of the Supervisory Board (Aufsichtsrat) of a corporation. This subject is treated in greater length in Volume II of this report.

3 The term "mittelständische Industrie" is used to denote German business firms with 500 or fewer employees. This group of small to

- 7. The organization and operations of the German educational system with particular attention paid to the vocational education system.**
- 8. The German legal system as it evolved from Roman Law, and the impact of the Napoleonic Code on legal and economic thinking in Germany.**
- 9. German history and culture.**
- 10. Other factors as they became evident to the research team.**

By perspective, we mean that these various institutional factors are to be viewed from the perspective of an American, that is to say, that the differences between the German and American experience are to be noted and, wherever possible, explained in a descriptive as opposed to a judgmental manner. The emphasis is to be on understanding Germany *per se*, as opposed to contrasting it to the United States.

Further, the content of the research was to be heavily weighted towards an understanding of the decision-making process in German industry. Put simply, the research is to illustrate the interplay between various institutional forces as they are found in Germany and the operations of its industrial system. In order to accomplish this, it was felt that a reasonably broad body of knowledge had to be collected and presented in as descriptive a manner as possible thus allowing the informed readers to draw their own conclusions.

Understanding Germany

With this as a starting point, the project staff has already developed information on a number of facets of the German "system." Although Volume II of this project deals in-depth with the German system, the best synopses of the tentative findings of the research staff can be found in the appendix to this chapter, a matrix which compares key factors in the U.S. national system to those of the German national system.

Two issues need to be noted here. One, the matrix is not yet complete. It will be added to as the project develops new insights into the various differences between the U.S. and German systems. Two, not all of the substantive areas noted in the matrix have been adequately researched. In this respect, the matrix is as much a guide to the learning that has been accomplished to date as it is a protocol for the future.

More work needs to be done here. It has been decided, however, that this additional work will be experientially based. Specifically, more on-site data on the decision-making process in Germany will be collected and analyzed in later phases of this project. For example, given the vitality of the "Mittelstand" and its significant contribution to the export side of the German economy, more needs to be known and understood of how these firms adapt to a very dynamic domestic and international economy. We need to know how environmental realities such as the institutional forces noted above

medium-sized firms, most of which are privately owned, is regarded by most knowledgeable observers as the hallmark of German industrial structure. It is this group of very dynamic smaller firms that account for 70% of the German export base. The term "Mittelstand" is used in this report as opposed to the more grammatically correct "Mittelständische Industrie."

are factored into the strategy formulation and implementation process in these middle-sized firms. How does management respond to, say, the organization and structure of the banking system, to the vocational education system, and to other political, economic and social forces as they are found in the German national system? And, how do they interact to create an extremely dynamic and forward-looking economic structure?

From an academic perspective, then, we are suggesting that the key focus of this project should be on the development of information and analyses that are practical in scope and context. To wit, how can the American academic and industrial community better understand those factors which have helped to create and sustain a vital and dynamic German economy and social system?

Summary

In American parlance, then, the project staff is dedicated to the development of a series of "lessons learned." By this, we mean the development of a comparative body of knowledge on industrial operations in both the United States and Germany that can be used by the relevant decision-makers as a tool for promoting improvements in the overall national and international environment in which their country and firm operates.

There is much that Germany can learn from the United States. And there is much that the United States can learn from the German experience. The purpose of this project is to promote this learning.

EXPLANATORY MATRIX

United States	Germany
<i>Ideology</i>	
Individualism	Communitarianism
Free market economy	Free market economy
Common law.	Codified law (Napoleonic) based on Roman law.
Countervailing power	Consensus Formation.
Antipathy towards the development and/or the espousing of a national industrial policy.	Industrial policy an integral part of the legislative process.
Sense of nationhood well defined.	Continuing search for national identity, increasingly sought on a supranational European Community Level.
<i>Economics</i>	
Free market economy.	Free market economy.
Laissez faire attitude towards business.	Defined national policies with political beliefs on the communal responsibilities of the business community.
Price-oriented managerial concepts and practices.	Cost-oriented managerial concepts and practices.
Domestic markets dominate the economy.	Export dependent economy.
Large companies dominant.	Middle-sized companies the centerpiece of the industrial structure.
Active primary and secondary stock market: equity-based capital structures dominant.	Small stock market, bank financing dominant: debt-based capital structures dominant.

United States**Germany*****Economics (continued)***

Emphasis on publicly-owned (traded) firms.

Antipathy towards subsidizing industrial development other than defense.

Identifiable defense industry.

Low savings rate (individual)

Emphasis on privately-owned firms but with increasing number of publicly-owned firms. (AG)

System of subsidies for key industries termed critical to a growing economy.

Defense industries integrated with civilian industry.

High savings rate (individual).

Education

No national control of school systems, educational standards, or certification procedures.

Academically-oriented system; little or no emphasis on vocational education.

Lessened emphasis on science and engineering programs at the university level.

Engineering and science not regarded as most appropriate training for managerial positions.

Little emphasis on "hands-on experience" as an integral part of the formal education system.

Professional standards rarely defined by the government.

Federal and state systems, with the Federal government providing policy inputs, but with the states as the "supreme authority" in matters of education.

Heavy emphasis on vocational and continuing education system, federal and state sponsored and managed.
Comprehensive work skills testing and certification procedures. Major emphasis on apprenticeship training programs.

Major emphasis on science and engineering programs at the university level up to the master's level.

Engineering regarded as the best training ground for future managers.

Hands-on experience, or "Praktika"

Professional standards always defined by government.

United States**German*****Education (continued)***

State Certification of teachers.

Länder standards and certification; teachers and professors are civil servants of the individual Länder.

Outcome assessments arbitrary to non-existent.

Standardized outcome assignments: Federal rules and guidelines in force.

Private and public school systems.

All education public and free, at all levels of schooling.

Local funding.

Federal and state funding.

Corporate Governance

“Unitary”Board of Directors responsible for the management of the corporation..

Board of Directors (Aufsichtsrat) separated from corporate management. (Vorstand)

Members of the board may also be the managing executives of the firm.

Half of Board elected by stockholders, other half by labor. Board appoints management group. Member of the Board may not be a member of management and vice-versa.

By tradition, no labor representation on the Board or in the management of the firm.

By law and tradition, labor now allowed to appoint the firm’s personnel manager (Betriebsrat).

Common stocks in owners name.

“Bearer” shares normally held by bank (as clearing agent) for owners. Right of proxy normally granted to banks.

Legally-restricted ability to interfere in the management of the non-financial firm.

Significant ability, legally and otherwise, to interfere in the management of the non-financial firm.

Primary responsibility to stockholders.

Primary responsibility to community.

United States**Germany*****Export Base***

Big company oriented.	Mittelstand-oriented.
No overt subsidies to exporters.	Remission of specific taxes and other forms of subsidies.
Long term trade deficit.	Long-term trade surplus.
Second largest exporter in the world.	Largest exporter in the world.

Labor Policy

No defined national policy.	Defined policies, 70% of gross domestic product “rule”.
Company-level union negotiations.	Industry-level negotiations.
No union participation in management.	Union participation mandated by law.
Unions focus primarily on local or regional problems.	Unions often focus on national labor problems providing inputs to national industrial policy.

Civil Service

Anti-bureaucratic tradition.	Strong civil service tradition.
Role of civil service limited.	Major role of civil service in all areas (the law included)

Legislative Oversight of Defense Industries

Substantial Congressional oversight.	Negligible oversight once programmatic decisions made.
Annual funding cycle.	Multi-year funding.
Separate accounting and standards systems for defense industries.	One system only for all firms.
Heavy emphasis on price competition.	De-emphasis on price competition: industrial base too small in many cases.
Primary issue: price.	Primary issue: quality.

United States**German*****Tax Policies*****Revenue-oriented****Investment-oriented*****Banking System***

Glass-Steagal emphasis.

Banks and other financial institutions either “discouraged” or otherwise not allowed to actively participate in the management of non-financial corporations.

“Arms length” banking.

Retail banking emphasized.

No governmental ownership of banks or financial institutions.

Strong central bank.

Universal banking system.

Long tradition of significant bank ownership of the common stock of non-financial corporations, and active involvement in the management of these non-financial firms.

Relationship banking.

Wholesale banking emphasized.

Mixed government, private sector ownership of banks based primarily on specific banking function.

Strong central bank.

Technical Standards

Separate industrial and military standards.

Loosely codified.

Industrial standards as well as defense industry standards.

Strict codification.

Industry Level Competition Theory

Differentiation.

Domestic.

Stockholder return.

Profits.

Price competition emphasized.

Niche.

International.

Business growth.

Market Share.

Quality and utility of product stressed.

United States**Germany*****Industry Level Competition Theory (continued)***

No concerted emphasis on high value added products.	Emphasis on high value-added products
Heavy emphasis on consumer goods.	Emphasis on producer goods.
No great stress on capital intensity.	Capital intensive manufacturing.
Production line orientation.	“Product”-oriented production systems.
Economies of scale oriented.	Small lot orientation: emphasis on flexible manufacturing systems.
Tendency to high overhead structures.	Low overhead structures; de-emphasis of middle management function.

Chapter 1: A NOTE ON RESEARCH METHODOLOGY

Because of the exploratory nature of this research effort, it was decided that there would be no hypothesis formulation stage. The research would begin, instead, with a number of site visits to firms involved in the manufacture of the main battle tank.

To start the research process, a series of visits were made to U.S. defense industrial firms starting with General Dynamics, the prime contractor for the Army's Abrams tank. Based on the meetings with various General Dynamics personnel, a population of eight lower-tier firms was then selected. As discussed in the body of the report, these include an optics manufacturing firm; the manufacturer of a key "electromechanical system"; a number of subsidiary lower-tier mechanical and electrical parts manufacturers; a materials supplier, in this instance a large-scale ball bearing manufacturing firm.⁴

The German team made similar arrangements and ultimately arranged interviews with ten German firms. The data developed during these site visits was, as discussed in Chapter Five, supplemented with public source data. The firms in the German sample include an electronics manufacturer, a medical technology firm, and six other firms in the metal or metal-based

manufacturing industries, that is to say, gearboxes, power trains, armor plate, suspension systems, and turret stabilization systems.⁵

In addition to the domestic field trips, concurrent trips were made by the American-based staff to Germany in order to gather "first hand" data on the German economy and to verify that the project team's understanding of the data was consistent with the German perspective of the same body of knowledge. The focus of these trips was to develop an understanding of the legal, economic and cultural environment in which German industry operates. Factors such as the organization of the German banking system, the governance process in German corporations, the role of the German Central Bank (*Bundesbank*), the structure and role of the German civil service, the German defense industrial base and the German educational system were carefully reviewed and the American team's understanding of these factors verified.

The focus of this analysis was two-fold: to discover if the German defense industry was potentially more robust than that of the United States in that it may have a greater ability to survive during a period of stringent funding cuts than its U.S. counterpart; and, if this is so, to

4 In terms of sales volume, the firms ranged from the division of an \$8.0 billion a year firm to independent firms in the \$5.0 to \$15.0 million a year category. As was expected, some of the firms are easily categorized as "high technology" firms, whereas others are what might well be termed "basic" manufacturers. As was also anticipated, the larger firms are only minimally dependent on the sales volume generated by the Abrams tank, although this statement may not be true for the specific divisions or affiliates that now contribute to this program. Like the smaller firms, all of which are significantly dependent on the Abrams program, these divisions are now faced with tenuous business and financial futures given the currently planned 1994 shut-down of the entire program.

5 In terms of sales volume, virtually all of the German firms included in the sample can be classified as large-scale firms, i.e., total sales in excess of \$500,000,000 per year. Three of the firms with defense sales in excess of \$400,000,000 per year are divisions or affiliates of far larger firms. With but one exception, all of the remaining firms had sales in excess of \$1.0 billion. The one exception was a medical technology firm with sales in the \$500,000,000 per year category. In all cases, defense sales, and those of the Leopard-2 program in particular, accounted for a small portion of the firm's total sales revenues.

advance some cogent reasons explaining why this outcome has, or will, obtain.

Sample Size

The size of a sample is, of course, a key methodological issue in most survey-oriented research projects, and it was recognized early on that the small sample size that selected might not allow the research team to draw fully valid conclusions about the state of the industrial base on which the Abrams and Leopard-2 program relies. Conversely, given the extensive acquisition research background of both the American and German project staffs, it was felt that the small sample would still provide the type of information useful in making viable suggestions about future research methodologies directed at more cogent understanding of the impact on the various defense industries of future reductions in the defense budget.⁶

A Generalists View

Done from the perspective of a "generalist," the inter-country comparison proved to be an extremely effective research methodology. In order to properly understand the industrial operations of a foreign country, the observer must first objectify his understanding of his own nation. By this, we mean that he must make certain that his knowledge of his own country is more factually than intuitively based. There are, for example, institutional forces in our own system what we tend to take for granted. We

prefer to believe that we understand the historical forces that created these factors and how they now act as integral part of our own political, economic and social system. Unfortunately, as we learned, it is not that simple. For example, our adoption of the British form of common law as opposed to the Napoleonic code has a very definite impact on the differences between the United States and Germany in the corporate governance area. In turn, the governance procedure and the legal ideologies underlying it, has had a profound influence on the respective industrial structures of each of these two nations. These differences were explored as part of this project. Compounding such basic research difficulties as these is the language difference between the two nations and, most pointedly, the psychological underpinnings of that language. In the instance of Germany, these differences are particularly relevant.⁷

Summary

To sum up, a variety of research methodologies were used in the project. No one hypothesis took precedence in structuring the research, with the possible exception of the thesis that the economy and industrial structure of the United States and Germany differ, and that these differences might or might not have a profound effect on the robustness of the indigenous defense industrial base. The report that follows talks to these issues.

Macro-Economic Studies

Before moving on to a discussion of the tasks completed as part of this research project, a last note on research methodology is essential; that

is, the fact that a substantial number of macro-economic studies have been completed which address the issue of the impact on U.S. industry

⁶ Here it should be noted that General Dynamics identified as "participants" in the Abrams program a population of approximately 4500 domestic firms. In theory, all of these firms could have been included in a formal survey, but this would require more time and resources than appears justified.

⁷ For example, as a result of a number of historical and geographical variables dating from its initial formation as a nation, Germany has been required to be a high-value added exporting nation. Over time, this requirement has helped to create a different view of the production process and the concomitant use of technology than now exists in the United States. In turn, the pressing need to export has affected the German view of industrial training and, ultimately, the structure and long-term resilience of German industry. In order to understand these differences, it was essential for the research staff to look at the U.S. industrial environment in a far more structured way than is normally done. In very important sense, this heightened awareness of U.S. economic and industrial organization helped to clarify many of the observations made during the U.S. field trips discussed at length in Chapter 3 of this report.

of the planned reductions in the defense budget. Most of these analyses agree that the currently planned reductions will result in the loss of between 800,000 to 1,000,000 jobs over the next one to five years. Simply put, the defense industry and its related industrial base will suffer significant shrinkage over the next few years, repeating albeit in a new economic context the industrial conversion history of the post-World War II and Vietnam War eras.

It is difficult to argue with these conclusions; the macro-economic evidence is far too persuasive. If nothing else, there are easily derived correlations between the size of the defense budget and the number of people for whom this budget provides jobs. At issue is not the number of jobs that will be lost, but (1) whether the civilian economy can currently or prospectively absorb this labor force as it becomes available, (2) whether it will be possible to reconstitute this industrial-based military capability should the need arise in the future, and (3) whether it will be possible to preserve those special human

capabilities needed for the manufacture of specific military products.

The ability of the economy to absorb the reduction in the size of the defense industrial base labor force is, of course, beyond the scope of this analysis. The absorption of approximately 1,000,000 skilled workers into the work force is dependent on general growth factors in the U.S. economy, and, to a great extent, on our ability to either offset the flow of imports into the United States or otherwise increase our export base. All of these subjects are now conjectural although it seems obvious that national programs will have to be developed that encourage either one or both of these outcomes. Although this issue is well beyond the scope of this project, it is worthwhile to note that the economy adapted itself in the late 1960s and early 1970s to an equal, if not potentially greater, drop in the size of the defense and defense-related industries. More will be said of this in later sections of this report.

Chapter 2

THE UNITED STATES

The History of Prior Industrial Mobilization Effort

World War I

The history of our industrial mobilization effort during World War I is not relevant to the current analysis.

First, our participation in the war did not come until quite late in the conflict. Second, prior to our active participation, we had very little by way of military equipment that we could offer the Allies. Indeed, we had to depend on them for the design and production know-how for substantial portions of the equipment that we ultimately built. The French 75 gun is a case in point. Third, neither the French nor the British industrial base was destroyed during this conflict, although the French did lose some capability in those parts of the country that were occupied by the Germans.

This is not to suggest that the Allies did not look to the United States for help but rather that these requests had a minimal effect only on our industrial base, ship building excepted. Here, as in WW II, we produced thousands of ships just in time to see peace declared and the need for the ships nullified. We dumped them on the world market place after World War I, creating then, as in the period immediately after WW II, a prolonged depression in the world-wide ship-building industry.

Last, WW I was primarily a prolonged and agony-ridden infantry battle. The one resource that was consumed in immense portions was young men. The concept of substituting capital for labor in military force structures had not yet surfaced.

World War II

Given the size, duration and theories of combat that the United States then used, it was essential to mobilize virtually the entire U.S. economy and its population to wage World War II. As an essential footnote to the scope of this conflict, it should be noted that more than 12,000,000 Americans were on active duty during 1944 and 1945, the last two years of the war. Moreover, an additional 3,000,000 persons served in the Armed Forces between 1940 and 1946, thus bringing to approximately 15,000,000 the number of military personnel mobilized for the effort. The level of supplies needed to wage the war was commensurate with the size of the armed forces. For example, 229,000 aircraft were built during the war as were 5,777 ships. The equipment and supply base in other military areas was equally large, giving birth to the notion of an industrial "Fortress America."

Prior to the war, other than some Navy shipyards plus an arsenal complex of no significant size, the U.S. had neither a defense industry nor what would now be termed a defense industrial base. Thus, in order to mobilize, the U.S. converted a peacetime industrial and consumer goods manufacturing capability to military production. Elements of that industrial base remained "mobilized" through 1954 despite the fact that the war ended in 1945.

The main industrial and technological force behind the conversion to wartime production was the domestic automobile industry. General Motors, Ford and Chrysler took the lead in military production and manufactured significant ele-

ments of our military requirements to include not only the expected trucks and cars, but also tanks, other tracked vehicles and aircraft. Indeed, the automobile industry produced more aircraft than did the aircraft industry, *per se*.

In retrospect, the reasons for this last outcome are fairly obvious. The U.S. didn't have much of an aircraft industry prior to 1939. The companies in the industry were, for the most part, small and under-financed. Prior to WW II, their primary function was the design and development of aircraft and the subsequent production of what we might now call prototypes. Intriguingly enough, all of this was done in an entrepreneurial mode.

Because of its own complex of shipyards, the Navy took on the major responsibility for the construction of naval combatants. However, the Navy was aided in this effort by the relatively large number of commercial shipyards then extant in the United States. These yards expanded rapidly to meet wartime needs, as did the steel industry. Kaiser Industries and Bethlehem Steel are among the more well-known firms that either entered or expanded their long-standing position in the ship building industry.

The machine tool industry similarly expanded from a relatively small base meeting the enhanced demand for machine tools in all affected industries. It contracted in size after the war but with a relative degree of ease. Then, as possibly even now, the industry consisted of a large number of relatively small family-owned firms.

Critical to a full understanding of the post-war conversion period is the fact that both U.S. industry and the American consumer exited the war far richer than they entered it. Because of the Depression that lasted from 1929 to, at the minimum, 1940, there was a significant lack of buying power in the economy. As a result of this, much of the production of consumer, industrial and public goods came to a halt. More-

over, virtually all non-essential consumer-oriented production was curtailed during the war, leaving the country with a very large basket of unfilled consumer and producer demands. The "catch-up" demands generated in both the 1930s and 1940s were not fully satisfied until the late 1960s.

Moreover, WW II was not really a "high-tech" war. To fight the war as the U.S. did, the type of "high-tech" equipment that is now the signature of modern force structures was not essential. As a practical matter, this equipment didn't exist then nor did the knowledge that would ultimately be needed to develop, design and build this type of military equipment. The technological revolution in military equipment came after WW II, as did the initial formation and growth of what we now call the defense industry. It is this latter fact which puts in doubt the relevance to the 1990s of the mobilization history of World War II.

Although post-war conversion to civilian production was accomplished in what now appears to be an effortless manner, there were many voices then that expressed the concern that a post-war depression was likely. However, what was not recognized by these "doomsayers" was the level of pent-up demand for consumer goods and the levels of savings available to make real this demand for goods and services.

Also missing from their analyses was an awareness of how completely both the European and Asian economies had been destroyed. Given that Europe and Asia were utterly destroyed economically, as the "only show in town," American industry, was faced with real levels of demands never before seen in a peacetime economy. Given this, market forces working on their own were able to resolve the conversion issue. Demand exceeded supply; producing enough was the key issue, with price oftentimes subordinate to demand factors.

There are, of course, exceptions to this general rule. Shipbuilding is one. The steel industry may be another. But for the greater portion of the domestic economy, the twenty-five years after WW II were boom years.

Vietnam

The history of the industrial build-up for the Vietnam war is far different than that of World War II. First, from 1945 on through the 1960s, the U.S. economy boomed. Indeed, the U.S. was able during those years to exert a form of economic hegemony over virtually all of the other democratically organized industrial countries.

Second, a large percentage of the industrial labor force was still made up of the highly skilled technicians trained during and shortly after WW II. In point of fact, it has been conjectured that the quality of U.S. labor was one of the key reasons for the growth in domestic productivity from 1945 on through at least the early 1970s. It has also been conjectured that the increasing age of the industrial labor force is one of the major reasons for the subsequent decrease in productivity gains in the United States.

Third, by the 1960s, a high technology defense industry had been developed in the United States for whom a production-based mobilization effort differed only in quantity but not in kind. It was during this time period that firms such as TRW, Hewlett-Packard, Litton, Textron, General Dynamics, Boeing and others developed and became large-scale businesses. Equally critical to the Vietnam mobilization effort was the existence of a then prosperous and technologically modern industrial base capable of quickly meeting the expanded manufacturing needs of the major primes contractors.

As shown in Figure 1, (on page 8) providing representative data on employment trends within the U.S. aircraft industry from 1962-1989, the mobilization-based increase in the

labor force was extremely rapid from approximately 1966 to 1969, the peak years of military production for the Vietnamese conflict. The subsequent reduction of the level of employment in the aircraft industry was equally rapid. For the most part, these persons were absorbed back into the civilian labor force without any undue strain in an economy which was still expanding and was not then subject to the type of foreign competition that evolved in the middle to late 1970s. Data on a number of other defense or defense-related industries is shown in the Appendix to this volume.

Conversely, specific elements of the defense industry suffered substantial capital losses in the early 1970s. By 1972, for example, the total market value of the U.S. aircraft industry ³⁷²¹was a bare \$250 million, a rather unimpressive sum of money even then. Other defense firms were similarly situated financially, some due to the nature of the defense market *per se*, and others for their failure to recognize the relatively short period of time that it took to mobilize the defense industry for the Vietnam war. The net result of this was that some defense firms exited the industry voluntarily in the early 1970s while others were forced out for financial reasons. However, if there were major strains in the economy as a result of the reduction in defense procurements, they were overshadowed by reasonably favorable domestic economic conditions.

Thus, the Federal government had no need to develop a policy and/or a program for a controlled scale-down of the defense industry. Free market forces were allowed to prevail and worked successfully consistent with U.S. economic ideology.

Notwithstanding this, some suggestions were made by the Federal government as to how the defense industries might convert to civilian production. Those few firms that attempted to go commercial, Grumman and Rohr Industries for

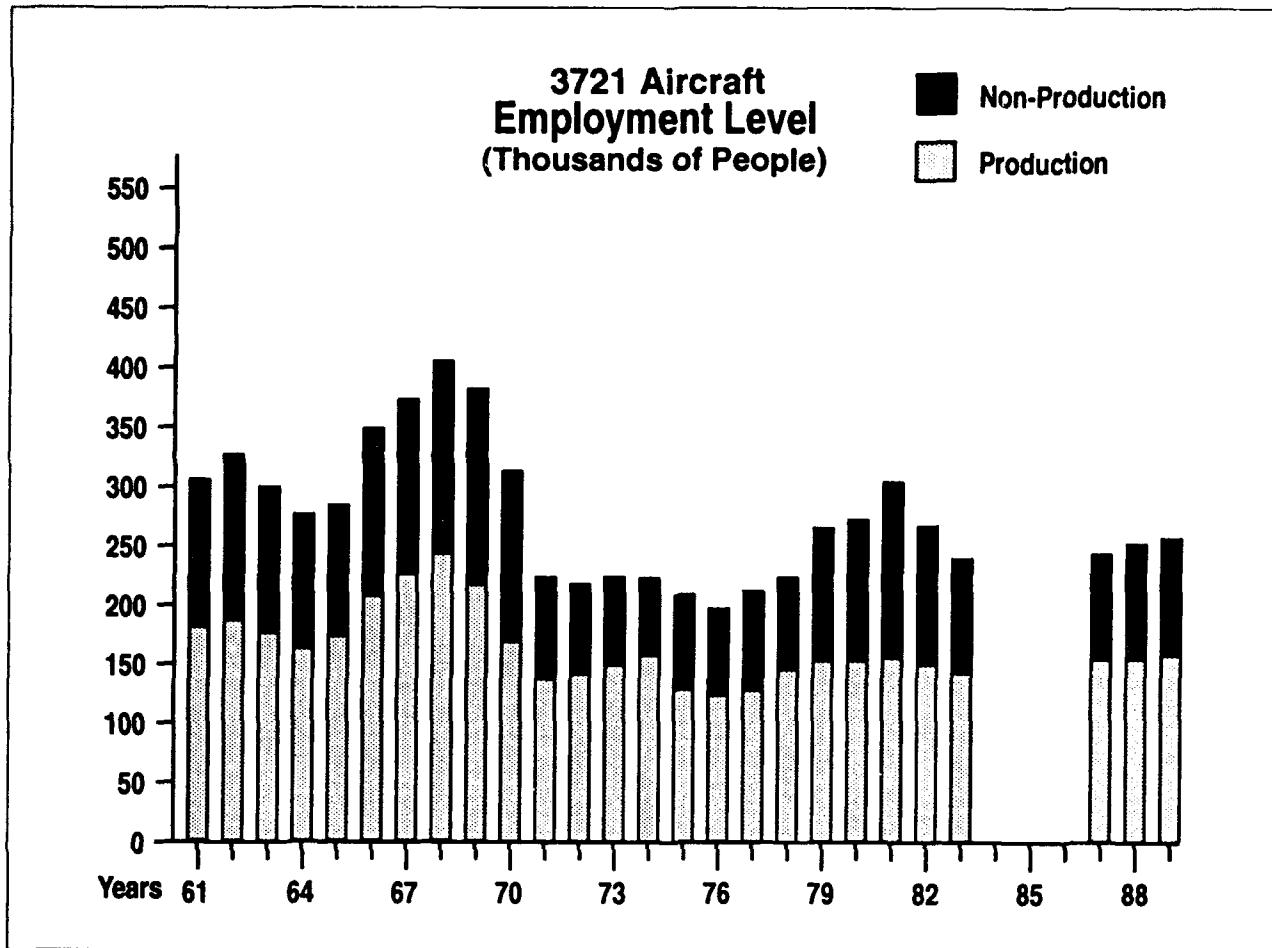


Figure 1. Employment trends in the U.S. aircraft industry, 1962-1989

example, failed rather abjectly. Based on this and other evidence, it seems reasonable to conclude that the conversion process is a difficult one and that very few firms have been able to make the required adjustment. In this regard, our experience in the post-WW II period is irrelevant. The major producers of military equipment during WWII were commercial firms with deep roots in the civilian economy. For them, conversion meant their returning to businesses in which they then enjoyed preeminent positions world-wide.

Because the down-sizing of the defense industries that took place after Vietnam was unplanned, in the opinion of some observers it had an extremely damaging effect on specific elements of the U.S. defense industrial base. In the

opinion of others, the effect was far more benign. The economy adapted, and the large number of now ex-defense workers found new jobs. Because of this, no final judgment on the relevance of the post-Vietnam period to today's economy can be drawn. However, as discussed later, the down-sizing of the defense industries in the 1990s will take place in a far different world than that which obtained in the post-Vietnam era.

Producer vs. User Nations

Before proceeding further, a comment on the organization and structure of the defense industries and the markets in which they operate appears to be in order. As noted in a study of various elements of the acquisition policies of a number of NATO nations, it appears essential

from an industrial perspective to distinguish between producer nations and user nations.⁸ Here, producer nations are defined as those countries that both design and develop as well as produce a given weapon system. The user nations are defined as those who either produce systems developed by others, or otherwise buy systems in the "open market." In this instance, the buying country leaves the development process to other countries, typically the United States, until recently the Soviet Union and, at least in the early 1980s, France.

The most cogent factor here is the fact that the industrial structure underlying the production of weapon systems is far different in a producer nation than in a user nation. Most typically, a producer nation has to make a far heavier economic and financial commitment to the design and development process, or the "intellectual property" development phase, than does a user nation. Thus, a much broader spectrum of industries and companies is involved in the acquisition process. Thus, when a down-sizing of the defense industry is mandated, far more firms and persons are going to be affected. However, the problem is far more complex than this. The complexity arises from the fact that a down-sizing effort involves not only the final production of a weapon system, which is the most obvious and easiest portion of the down-sizing effort to analyze, but from the fact that a producer nation can, in the scale-down period, destroy its future ability to create the intellectual property that is the basis for the technologically-based force

multipliers that are an inherent part of an effective force structure.

The conundrum here as it affects the U.S. is that key weapon systems producers in the United States are not only manufacturers of military equipment but also the business entities that do the initial design and development work. Unless carefully managed, then, a down-sizing effort can put at great risk the maintenance and/or future development of the intellectual property development process that underlies the force multiplier concept that is a major element of U.S. military doctrine.

From the 1970s to the Present

Extrapolating the ability of the United States to reconstitute its defense industrial capability using the experience of the 1970s and early 1980s as a guide can be extremely misleading. Not only has the structure of the world economy changed since then, but so has that of the U.S. economy and the industrial base on which its economy relies. Indeed, some of the changes have been far more radical in scope and content than is otherwise recognized.

First, a significant portion of U.S. industry has "internationalized" itself over the past twenty years, and especially the larger company that is regarded as the "backbone" of the U.S. economy.⁹ Many of our major corporations now generate as much as 40% to 50% of their sales and income from foreign subsidies. Central to the reconstitution concerns of this project is the fact that this trend has been accompanied by the

8 For a full discussion of this matter, see Edward M. Kaitz, *A New Approach to the Pricing of Major Weapon Systems*, Edward M. Kaitz and Associates, Inc., Glen Echo, MD, 1984.

9 For a more complete discussion of this issue see the *Wall Street Journal* for August 10, 1992. In an article entitled "For New Jobs, Help Small Business," it is noted that the Fortune 500 now employ slightly less than 12 million people, or 10.9% of total non-farm employment in the United States. The peak year for employment for the Fortune 500 was 1979, when this select group of companies employed approximately 16.2 million people, or 18.0% of total non-farm employment in the United States. In terms of its share of total non-farm employment in the United States, 1969 was the peak year for the Fortune 500. At that time, Fortune 500 companies accounted for 21.0% of domestic non-farm employment. A substantial portion of the loss in jobs with Fortune 500 firms is attributed to the relocation overseas of many of these firm's manufacturing facilities.

movement out of the United States of substantial portions of manufacturing know-how and capabilities. Further, this movement has created a concomitant shift in their "sourcing" practices, that is to say, an increased reliance on foreign sources for materials and supplies, a substantial portion of which are manufacturing-based.¹⁰

Second, apart from the overseas movement, many U.S.-based manufacturing industries and firms have seen their technical capabilities erode. In some instances, this erosion was caused by low cost foreign competition that drove the domestic firm out of its traditional marketplace. In other cases, the lack of depreciation-based incentives in our tax codes along with a reputedly higher cost of capital than that of its foreign competitors created a competitive environment in which the U.S. decision maker was understandably loathe to invest in new plant and equipment. Last, some of the erosion represents nothing more or less than poor executive-level judgments.¹¹

Irrespective of their cause, however, all of these factors have resulted in the movement out of the United States of a substantial number of highly skilled manufacturing-based jobs. Except as U.S. industry is encouraged to redevelop many of its manufacturing capabilities, the loss of many defense-related work skills will be permanent and, in all likelihood, unrecoverable. Here, there is the proverbial "chicken and egg" problem which has yet to be resolved. Did, on one hand, the manufacturing capabilities of significant segments of U.S. industry deteriorate because of the lack of a properly skilled work

force, or did the size and competitiveness of the work force decrease because of the lack of jobs?

There is no one answer to that particular problem. However, unlike many other problems addressed in this report, this one has a solution, and it lies in the development and implementation of skill-related training programs which both allow and encourage American industry to up-grade the quality of its labor force.

Of particular relevance to this discussion is the issue of "educational culture," that is, the type of work and skills training that we in the United States regard as "socially acceptable." Since the end of WW II, we have placed an amazing emphasis in the United States on collegiate-level education to the now obvious detriment of work-skilled or vocationally-based education. Indeed, in the United States, this latter form of education is oftentimes regarded as "second class," as are some of the jobs associated with it. For this, as the macro-economic evidence now attests, we have paid a high price not only in our overall ability to compete internationally, but in the actual loss of a significant number of jobs that traditionally provided better than average incomes for a large number of young Americans.¹²

Returning to the focus of this project, many of these desirable work skills now found in the defense industries will be lost as a direct result of the reduction in our defense budget. Moreover, as became evident during the field stage of this project, a large number of the smaller manufacturing firms that make up a significant portion of the lower tiers of the defense indus-

10 For a discussion of this and related matters, see David Parker, "Impact of Offsets on the U.S. Defense Industry," an unpublished paper, Marymount University, Arlington, VA, July 1992.

11 For a full discussion of a number of critical and industrial issues see Dertouzos, Lester and Stow, *Made in America*, the MIT Press, Cambridge, Mass., 1990.

12 An excellent discussion of the state of the United States educational system that speaks to this and related issues can be found in *Thinking for a Living* by Ray Marshall and Marc Tucker, Basic Books, New York, 1991.

trial base will either drop out of the business or otherwise close down, further reducing the supply of manufacturing-oriented jobs. Thus, given the presently relatively low level of demand for industrial workers in the United States, it appears unlikely that any more than a minor percentage of the available skilled work force will be able to find the type of job that requires the technology-based skills that they previously acquired. In time, their skills will be lost to the marketplace, further reducing the employee skill levels needed to maintain a high quality, highly competitive manufacturing base.

For this and the reasons noted above, the impact of the reductions in the defense budget in the 1990s is apt to be significantly different than in the 1970s and early 1980s. Here, by the way, demographic realities will come into play. A significant portion of the Vietnam era labor force was trained to their work skills during and shortly after World War II. This work force has aged. Some have already retired, and many others are due to exit the work force permanently in the next few years. This labor force will not be available to the United States should it be necessary in the future to reconstitute the manufacturing-oriented side of the defense industrial equation. Along with the loss of manufacturing-based jobs in the overall economy, this will complicate the reconstitution effort for some key military systems.

Structural Rationalization

The term "down-sizing" has been used to describe the adjustments that U.S. industry will have to make in order to accommodate to the projected reductions in the defense budget. For all practical purposes, this term is far too simplistic. Whether so stated or not by the Depart-

ment of Defense, the U.S. defense industry is now faced with undergoing a process which, in more formal economic and legal language, is termed "structural rationalization." This term is being used here now because it has been used before in both economic and political literature such that someone looking for a history of the "down-sizing" process could begin a fruitful bibliographic search with this as the leading descriptor.

However, it is a term far more often used to describe the economic policies of industrial nations other than the U.S. This is because there has been more of a felt need in Europe and Asia for "restructuring industries" than in the United States. And, in the instance of both Asia and Europe, government has oftentimes taken a lead in either forcing the economic rationalization of an industry, or otherwise "persuading" industry groups to voluntarily carry on the effort. Indeed, there is no history of any comparable U.S. experience with the planned rationalization or down-sizing of a sector of our private economy.¹³ Contrariwise, foreign governments have undertaken the responsibility for the restructuring process which is at the heart of the scale-down or down-sizing process. In general, the procedures appear the same from country to country although a detailed investigation of many of these histories may reveal subtle differences in the scope and outcome of these actions, with these differences a function of the country's legal, economic and cultural system.

For example, the British rationalized their shipbuilding industry in the 1970s. The prime motivation for the rationalization effort was to (1) minimize the loss of scarce capital that a failure to down-size an industry with excess capacity

¹³ From a very pristine perspective, the leveraged buyout (LBO) movement in the United States may well be regarded as a special case of a structural rationalization process. The key differences between the U.S. experience and that of the Europeans and the Japanese is the fact the the U.S. process was designed and implemented by the private sector without any government support or intervention. Moreover, the U.S. process was designed more with the stockholder in mind than with the need to reorganize critical elements of the U.S. industrial base.

can engender while (2) retaining a desired level of intellectual and manufacturing capability. The British have had similar experiences with other industries, as is evident from their propensity to both nationalize and denationalize industries, if only for politically inspired reasons.

As might well be expected, the Japanese have even more experience with down-sizing or rationalizing industries than do the British. The prime motivation for the structural rationalization process in Japan is their national policy of trying to preserve capital for later use in growing industrial areas. A secondary goal is the maintenance of at least a minimal capability in a given industrial area should there be a later resurgence in demand. The various rationalization efforts taken on behalf of their shipbuilding industry is one case in point. They have, however, taken similar action with respect to other industry groupings and will no doubt do so in the future.

The French have also undertaken the structural rationalization of specific industrial groups and, indeed, have nationalized and/or privatized a number of industries based on perceived national goals and/or needs. Parenthetically, they have used the rationalization process to both reduce the size of an industry or to help it grow into a world class producer, i.e., the French concept of the "national champion."

Although the Germans may have undertaken similar efforts, no bibliographic trail of their experiments exists.¹⁴ This is not to say that the effort has not been made but rather that the effort may have been carried on more discreetly using nationally-oriented industrial associations and major banks as the vehicle for stimulating de-

sired change. Conversely, the Swedish undertook industry rationalizing efforts as far back as the 1950s, albeit using different economic techniques to accomplish the down-sizing and/or revitalization of an industry or group of companies deemed to be operating in the national interest.

Returning to the United States, no such action has been taken by the government because of the specific philosophic cast of our political and economic system. Most pointedly, the U.S. believes in a market-oriented economy but with the additional caveat that the government not be involved in peacetime in the capital formation or preservation process as it affects the private sector.

This responsibility is left to the private sector. If supply exceeds demand such that an industry's capital base may be diminished or destroyed, our governmental policies generally remain neutral to this outcome. The U.S. government will do little to stop or otherwise impede the process. Thus, the decision to remain within or to exit an industry is regarded as an inviolate private right, one of the proverbial risks of our form of entrepreneurial capitalism. Without debating the wisdom, or lack of wisdom, of U.S. tradition, it needs to be recognized that this policy poses a potential problem in the instance of a cross-national development and/or procurement program. Our foreign ally will not view the rationalization process through the same filter. Most of our Allies do not believe that they can remain indifferent to the potential destruction of the capital base of their key industries. It seems reasonable to assume that these countries will make every effort to minimize this loss of down-sizing by pushing a

¹⁴ This statement is not entirely correct. Some information on the rationalization of specific elements of the German defense industrial base is presented from the German perspective in Volume III of this report. Additional insight into the on-going restructuring of the European defense industrial base, a process that was initiated in 1987 by private sector business firms, can be found in James B. Steinberg, *The Transformation of the European Defense Industry*, Rand Report R-4141-ACQ.

substantial portion of the cost onto U.S. industry in recognition of the fact that the U.S. government has no formal mechanism for interceding on behalf of a U.S. company. And even were the U.S. government to intercede, it would have no legal precedent to follow in determining what the outcome of the scale-down process should be, nor the financial and economic burden that the various parties to the scale-down should be forced to shoulder. In the final analysis, this reality is a major cultural barrier to the orderly scale-down or down-sizing of our defense industrial base.

Labor Theory and Practice

The major barrier to the development of a U.S. policy vis-à-vis structure rationalization is cultural. One of the more significant roots of this culture can be found in the prevailing U.S. view of the role of labor in a free market economy. In the United States, labor is regarded as a variable cost; when business is good, more people are hired; when business turns down, more people are fired. Traditionally, the management-labor relationship in the United States is best typified as an "arms length" transaction in which labor is required to play an equilibrating role in minimizing business risk.

Put in more formal terms, management theory and practice in the U.S. industry does not regard labor as a key "stakeholder." This is a perspective 180 degrees opposite to that held by management in most European nations, Great Britain being the key exception to this "rule." Indeed, recent court decisions in the U.S., flowing from litigation surrounding the leveraged buyout movement, have affirmed the primary responsibility of management to the stockholder, a far more restricted view of the rights and prerogatives of corporate stockholders than

typically found either in European law or practice.

In this regard, the U.S. government has long pursued a hands-off policy with respect to the private sector capital formation and allocation process, and the rights and responsibilities of labor within the context of this process. Indeed, given the tenor of the "countervailing forces" concept established in our Constitution, it is unlikely that the Federal government will ever take actions to change this political reality.

More will be said of this later in the context of the comparative study of industrial organization in the United States and Germany.

An Initial View of the Down-sizing Process

The most easily perceived and understood evidence of the impact of a scale-down in defense procurements can be found at the prime contractor level. The output of the relevant platform and hence the sales revenue generated by it will decrease along with the decreases in the defense budget. However, because of the impossibility of eliminating a number of fixed costs, unit output will inevitably decrease faster than unit cost. Put another way, as production is scaled down, unit costs will increase.¹⁵

Further, the impact on employment levels within the prime's organization will be readily measurable as will the latent ability of the prime to "ramp-up" production again, should this be necessary. A number of platform-oriented analyses of the time and money needed to re-institute either prior levels of production or projected "surge" levels have been made, and need not be repeated here.

The analysis surrounding the conversion potential of the prime contractor is, however, more

15 This last statement assumes that some level of production will be maintained. A complete phase-out of a program, such as is now planned for the Abrams tank, will not incur this "cost" penalty.

complex than that required to determine the prime's ability to resume full-scale production. First, there are many levels of "prime" contractors in any major program. To clarify this last statement, in the Abrams tank program, General Dynamics is *the* prime contractor as defined by the Defense Department. However, from a business man's perspective, those firms that supply systems, sub-systems and/or components for the tank on a government-furnished equipment (GFE) basis, are prime contractors in fact, if not in name. Measuring the impact of a scale-down on these firms requires the same level of analysis as for the prime contractor.

Notwithstanding the similarity in analytical technique, however, the projected outcome of each of these analyses can be expected to differ. Central to this difference is the fact that most designated prime contractors are defense firms, such as General Dynamics for the Abrams tank and McDonnell Aircraft for the F-15 aircraft, who are primarily dependent on defense acquisition programs for their sales revenue.

The same is not generally true at the GFE level as it is obviously not true for the lower tiers of the defense industrial base. Irrespective of their size, most of the GFE and lower-tier firms generate a substantial portion of their sales from commercial products. In this respect, they have already "converted" to civilian production, and the re-adjustment of their sales base and product orientation to commercial markets can be expected to be a function of their prior business history and the current condition of the economy. Where the demand for their product exists, it seems reasonable to assume that these firms will enter, or at least attempt to re-enter, these markets as an offset to their loss of defense production. Their ability to do so, however, will clearly be a function of such factors as general economic conditions, product demand, marketing capabilities, and the quality of the management team available to plan and implement the

required conversion. In addition, there are labor and machinery-based limits to conversion.

Both labor and machinery have a relatively fixed capability if only in the short to medium term such that the markets to which a conversion-oriented firm can aspire are necessarily limited by these two factors. In this regard, since each of these firms are relatively unique, determining their individual or even collective ability to convert to civilian production as a technique for stabilizing their sales revenue and the number of skilled jobs that they provide the economy, requires a company-by-company analysis. This subject is treated at greater length in Chapter Five of this report.

Defense Business as a "Target of Opportunity"

Unspoken in most analyses of the defense industries is the fact that the defense business is a "target of opportunity" for many firms, whether they be the divisions of large-scale firms or smaller, independently-owned businesses.

As suggested by Figure 1 and the various exhibits in Appendix A, the defense business displays a cyclical pattern indicating that, over time, any number of firms enter and exit the industry based on management's perception of demand factors. More realistically, many of these firms enter the defense markets when their anticipated commercial demand has "dried up" using defense production, if it is available, as an offset to their loss of an otherwise viable commercial market. Although the data is not clear-cut in this regard, this outcome apparently obtains more at the lower rather than the higher tiers of the defense industrial base. And, based on the admittedly anecdotal evidence gathered during our field visits, it is the smaller, general-purpose machine shop that exhibits this form of industrial behavior. Given this, and given the history of the post-Vietnam period, it seems reasonable to assume that a number of lower-tier firms will either shrink radically in size these next few

years, or otherwise disappear from the business scene.

Similarly, based on the post-Vietnam experience, it also seems safe to assume that a resurgence in military-based demand will be met by at least a partial resurgence in the size and vitality of these firms. This last remark is subject to a number of critical caveats:

1. That labor with the appropriate work skills is available in the community in which these firms are located or that labor can then be bid away from firms engaged solely or primarily in civilian production. This latter ability should not be taken for granted given the aging of the work force in many basic manufacturing industries and the overall loss of manufacturing capabilities in the United States.
2. That sufficient time and funds will be available for bringing this work force up to the skill level demanded by most defense production.
3. That the capital equipment needed to restore defense production will be available, that is to say, that it will not have become obsolescent over the years, or otherwise disposed of because of its lack of economic value.
4. That the work skills needed to start up defense production are no more demanding than those needed for the existing commercial market.

Notwithstanding the above, it is impossible to predict the future, especially at the micro-economic level. All economies go through continual adjustments because of a broad set of environmental factors, many of which are impossible to predict. For example, if the United States automobile industry makes significant changes in its manufacturing technologies as it adapts to new product lines, it may be able to provide ready access to defense-oriented pro-

duction should the need arise. Conversely, the domestic automobile industry could regain its prior eminence in the field but, given the global nature of most mature economies, by relying heavily on low-cost foreign subsidiaries and suppliers. In this event, they will not be able to fill a void in our defense production capabilities.

In the instance of the aircraft defense industry example, this has already happened in part, given the marketing need to provide some foreign customers with "offsets." In cases such as this, some otherwise domestic manufacturing capability is exported and, most likely, permanently.

The Defense Industry and the Defense Industrial Base Defined

The terms "defense industry" and "defense industrial base" are used in virtually all discussions of the weapon systems acquisition process and, quite often, interchangeably. This is to be expected inasmuch as there is no one generally accepted dictionary-based definition of the terms.

Since these terms will be used throughout this report, an understanding of the usage of the terms is essential. The terms are defined as follows:

Defense industry: the industry consists of those firms, irrespective of size, that derive a minimum of 30% or more of their annual sales from various weapons acquisition programs, that is to say, their corporate perpetuity is primarily dependent on a flow of funds from the defense budget. In this report, these firms are referred to as defense contractors, prime contractors, subcontractors, etcetera.

Defense industrial base: This term is far more inclusive and includes any industry or firm that produces products and/or services for any of the many weapons acquisition programs implemented by the Department of Defense. In par-

ticular, the term defense industrial base denotes those firms who participate in these programs but who are otherwise *not* defense contractors, prime contractors, etcetera. In this regard, (a) only a relatively minor portion of their sales are the result of the weapons system acquisition process and, more importantly, (b) the major strength of their business is in their commercial operations. The steel industry is an excellent example here in that only 8% to 10% of its final production is used in the weapon systems pro-

gram. Thus, the industry is only minimally dependent on the defense budgets for its annual sales and profits. There are other industries and firms that fall into this category. Indeed, it is conceivable that many firms are unaware of the fact that they can be correctly categorized as being part of the defense industrial base. Notwithstanding this, these firms will be affected by the proposed reductions in the defense budget.

These definitions will be used in the chapters of this report that follow.

Chapter 3

UNITED STATES TRIP SUMMARIES AND ANALYSES

Given the limited size of the sample of firms to be included in this analysis, advice on their selection was sought from the Land Systems Division of General Dynamics (GDLS) in Warren, Michigan. Based on their advice and the requirements set out in the Request for Proposal, eight firms were selected as the basis for the field research phase of the project. Their composition is as follows:

1. The defense industry division of a major U.S. corporation responsible for the manufacture of one of the more critical systems (force multiplier) on the tank.
2. A defense industrial base company that is the largest U.S. manufacturer of ball bearings and related types of equipment in the United States.
3. The American-based division of a large German corporation that is responsible for the partial manufacturing and final assembly of a key military system for the tank. The local company, as well as the parent company in Germany, is best characterized as a defense industrial base company. Moreover, the parent company may be classified as a major designer and producer of German military equipment.
4. A defense industry company in the optics business and an important supplier of optical devices for inclusion in various of the Abrams tank weapon control systems. With annual sales in the \$10-20,000,000 a year bracket, this firm is best classified as a small business, as are the rest of the firms used in this sample.

Defense output for this firm is currently 50% of the firm's final sales.

5. Two defense firms in the metal-forming industry that appear to have been competitors for their share of Abrams subcontracts in this manufacturing sector. One of the two firms appears to have elected to voluntarily liquidate its business interests over the past two to three years for reasons which are not entirely clear. The other firm has taken a more aggressive posture and is actively seeking for an industrial niche consistent with its core manufacturing facilities. Until recently, both of these firms had sales in the \$5-10,000,000 a year category. Moreover, both rely on defense sales for 100% of their output. Of this amount, the Abrams program has historically accounted for 40-50% of the relevant sales base.
6. A defense firm in the parts assembly business that has been traditionally dependent on defense procurements for 100% of its sales, with this sales base varying between \$5-10,000,000 annually. Based on management's statements, this firm has proprietary design and production rights to the products that it is providing GD, along with a relatively sophisticated design and testing capability. Although the firm is a division of a larger metal machining firm, there appears to be no tank product relationship between the parent firm and the division itself.
7. A defense industry firm that is a supplier of electronic components. This firm has sales in the \$5-15,000,000 a year bracket, half of

which are defense-related. The products that it currently assembles appear to be similar to those assembled in-house at GD's Sterling, Michigan plant.

Summary data on each of these firms is presented in figure 2.

The Content of the Information Collected
Because the key responsibility of this project was to develop a more thorough understanding of the type of research methodology appropriate to an action-oriented analysis of defense industrial base problems, specifically the ability of the base to survive in the short to medium term and its potential reconstitutability in the event of a renewed military threat, information on more generalizable business realities only was sought by the research staff. For example:

- The firm's present or prior participation in commercial markets and its inclinations in this regard.
- The relative level of sophistication of the manufacturing processes in use in the plant, and their potential competitiveness in commercial markets.
- The learning curve time needed to rebuild a production capability once its has been scaled down.

Given this focus, much of the data on the firms involved is, at best, impressionistic. One cannot gauge management's determination to develop new markets for their firm's capabilities, nor can one make anything more than an order of magnitude estimate of the time needed to reconstitute a firm's productive capability.

Moreover, there is a reality that needs to intrude in any analysis of this type, and that is the reliance of some smaller firms on defense production because of their inability to compete in more competitive commercial markets, the "target of opportunity" approach to corporate strategy alluded to earlier.¹⁶

It is impossible to determine if this is an appropriate statement to make vis-à-vis the business policies of the *specific* companies that we visited, but it is a known reality for many of the lower-tier firms that participate in defense production. Many of these firms would prefer to avoid defense production because of the intense price competition built into the process, the large amount of paperwork normally required of defense producers, the defense industry oversight responsibility of many governmental agencies, and similar factors.

But, given the DOD's programmatic requirement that calls for many primes to do intensive contracting with small business, it seems apparent that many potentially under-capitalized smaller firms have used defense procurements as one technique for insuring corporate perpetuity. Whether this applies to the smaller firms in this specific sample is irrelevant except as (1) it leads to an informed conclusion in that there are a significant number of small manufacturing firms that do *not* normally seek defense contracts but who are, nonetheless, capable of meeting defense needs should they ever again be required, and (2) seriatim, that reconstituting the lower levels of the defense industrial base may not be as complex a problem as heretofore been thought.

Based on this current analysis only, definitive conclusions on this issue cannot be drawn in this

16 As a rather general rule, most large defense contractors are required to set aside a specific portion of their subcontracts for the small-scale business. In the past five years, these set-asides have amounted to approximately 40% of all of the subcontracts entered into by the larger firms. For an interesting discussion of this topic, see "Minority, Small-Busines Subcontracting Record Faulted," *The Washington Post*, June 21, 1992.

United States Trip Summaries and Analysis

COMPANY	PRODUCT LINE	SALES VOLUME	% DEFENSE	CONVERSION ISSUES	RECONSTITUTION ISSUES	TIME TO RECONSTITUTE	OTHER COMMENTS
Company A	High quality optics	\$10-15M	50	Growing foreign competition. Commercial arena	No major impediments if business survives current downturn	2 years	"Job shop" production system
Company B	Metal forming of large parts	\$2-6M	100	Management has been slowly liquidating the firm	Number of other small firms with the required skills and machinery	1 year for a new vendor	"Low tech" operation with some "craft" skills required
Company C	Metal forming of large parts	\$5-10M	100	Now looking for opportunities in domestic auto industry	Number of small firms with the required skills and machinery	2 years	Relatively "High tech" shop. Well capitalized for its size.
Company D	Component assembly of hydraulic accumulators, auxiliary pumps	\$3-6M	100	Primarily a design, test and assembly operation with limited capability to enter commercial markets	Similar capability exists at some large firms for whom this firm now acts as a supporter	2-3 years if done in-house	
Company E	Wiring harness assembly of hydraulic accumulators circuit card assemblies, electro-mechanical assemblies	\$5-15M	50	Little difference between commercial and military applications	No major impediment. Low labor skills and relatively short retraining period required.	6 mo. - 1 year	"Low tech" operation performing some of the functions now done in-house by General Dynamics
Company F	Ammunition rack and related equipment	\$10-15M	100	Company plans to bid aggressively on broad areas of military procurements	None. Company sees growth potential in the U.S. defense market	None.	Division of a major German defense contractor that is also a significant player in a number of key commercial areas.
Company G	Weapon/Turret control	\$50-80M	100	No possibility to convert to commercial production because of product lines	Significant impediments once line is closed down due to high labor skills required. Other "high tech" manufacturing procedures, etc.	2-4 years.	Division of a major U.S. company
Company H	Bearing and bearing-related products	\$5-60M	5	Product line produced for both commercial and defense markets	None.	None.	Division of a major U.S. company

Figure 2.

regard. At best, it appears that there is little homogeneity in the organization and structure of firms that compete for lower-tier output, since some are technologically sophisticated, capital intensive firms and others are not, in that they are labor intensive, "low" technology firms.

It is for this reason, that we have recommended in Chapter Four a two-tier approach to defense industrial base research; force-multiplier research and product line research. We believe these conclusions are appropriately drawn from the site visit data that follows.

Company A

Product Line: Company A is a manufacturer of high quality optical glass, providing such components for the Abrams tank as lenses, windows, mirrors, mirror and window assemblies, prisms and prism assemblies, eye-piece lenses, and eye-piece assemblies. The firm presently makes about 15 items for the tank, and is currently (late 1992) shipping 20 to 40 of a given item per month. While their scope of supply is "built to print," they have worked with General Dynamics to revise the print if the part as designed was essentially impossible to make.

Commercial products include medical instruments, sporting rifle scopes, telescopes, microscope components, laser systems, blood, gas and water analyzing equipment, bar-code reader optics, and projection TV's.

Technical Capabilities: Despite its relatively small sales volume, Company A is the largest domestic vendor of high quality optics in the United States. They have complete in-house capabilities to make optical assemblies, including a Class 1000 clean room, extensive coating capabilities, environmental testing (temperature, humidity, shock loading) capabilities, and special FAT's, such as interferometry accurate to within 10^{-10} inches, all of which are required for complete manufacture of the tank components. In addition, the company has a great deal of general-purpose machines.

In general, the company's production facility is best characterized as job-shop oriented. Notwithstanding this, the company has extensive machining capabilities, and often manufactures the jigs, dies fixtures and custom machines necessary to properly make special parts such that it is able to attain mass production efficiencies on large volume orders.

Commercialization: From a business standpoint, this company is currently operating at about 80% of capacity, and is trying to fill this capacity with commercial work. The current sales breakdown is approximately 50% commercial and 50% defense, the vast majority of which is related to the M1A1 tank.

Reflecting the slowdown in the defense market, Company A has reduced its labor force in the past few months from approximately 150 persons to 120. The loss of production for the Abrams program will likely drive this number below 100. It will not, however, destroy the company.

Despite growing competition from overseas manufacturers, management believes that it can successfully compete for enough commercial business to maintain the company as a viable business entity. Nonetheless, as it is currently organized, this company is not geared up for competition in the high-volume commercial business arena. Given its current financial condition, and the projected loss in sales due to the reduction in defense budgets, Company A cannot now afford the required capital investments to remain completely competitive commercially with these foreign producers.

First, they have not been able to make the required investments in the latest cutting-edge automated equipment that is needed to be competitive in the commercial arena. Second, according to management, foreign competitors from Korea, Taiwan, Malaysia, and to a lesser degree Pakistan and India have already purchased the equipment required to be competitive in the high-volume commercial market, and are now active in the U.S. marketplace. This could lead to a further erosion in the size and capabilities of the domestic optical glass industry.

Reconstitution: To a great degree, the precision grinding of lenses is an art. Many of the optical components that Company A now manufactures for the tank are extremely difficult to make such that the learning curve time needed to qualify a replacement vendor might be as long as two years. The economic costs of the "first article" would mirror this length of time and might be as high as \$2-3,000,000.

A similar cost would obtain were the company required to reinstitute production in its own facility after a lapse of more than twelve to eighteen months. The primary problem here is a function of the time needed to recruit, rehire and retrain a work force capable of meeting Department of Defense quality standards.

Company B

Product Line: Company B is a metal forming plant specializing in the bending, cutting, welding, riveting, and painting of large custom parts. Prior to notifying General Dynamics that they intended to go out of business, it made 27 to 30 pieces for the tank, and employed 112 people. This company now employs 13 people and makes three parts for the tank: a left side stowage box, a right side stowage box, and a humidity-controlled, shock resistant storage container for laser sights. All of the firm's business is defense-related, and sales have fallen from \$5.4 million to \$1.8 million in the past twelve months.

Technical Capabilities: This firm's machine shop has a conventional job shop layout, with drill presses, milling machines, welding stations, riveting stations, and cutters. Less common equipment includes a large flame cutting table, several immense press brakes, a paint drying oven, and a robotic welding machine. Its equipment is mostly geared towards the production of very large parts, i.e., several feet in length.

Commercialization: From a business standpoint, this corporation is on the verge of extinction. Notwithstanding their earlier decision to liquidate the business, the company is currently searching for new business in such commercially oriented markets as trash compactor containers, weight

lifting equipment parts, air brake cylinders for trucks, and automotive stamping. These markets, however, are extremely competitive. Given its lack of high rate production manufacturing equipment for mass production, it is unlikely that it can become price competitive enough to sustain a position in these markets.

Reconstitution: Although there is some element of craftsmanship to quality welding and metal bending, the skills required to produce the parts now manufactured by Company B can be generally categorized as "low tech." Much of the art of making these parts involves meeting stringent flatness and length tolerances, which may not have a functional basis in the commercial arena.

Although a learning curve of up to one year might be required to transfer the responsibility for the production of these parts to another manufacturer, there are several domestic suppliers which now produce the same type products manufactured by Company C.

Company C.

Product Line: Company C, with current sales of \$7,800,000 per year all of which is defense-related, currently manufactures 70 different items for the Abrams tank. These parts generate approximately \$4,000,000 in sales annually. However, as reported by management, all of their production for the Abrams program is to be phased out by October 1993.

Technical Details: Company C has a shop similar to that of Company B. However, Company C is heavily invested in CNC lathes and milling machines, manual and robotic welding equipment, and two huge horizontal milling machines. Because of the large number of CNC machines that the firm owns, large runs of a given part can be done economically, utilizing a relatively low skill labor force. Short runs, however, require personnel skilled in setup and programming of these complex machines. Therefore, the skills required to complete a job vary with the volume of a given part. Notwithstanding this, the company is geared to be a relatively high level of manufacturing efficiency. Moreover, the president has a strong technological background and is capable of personally solving technical problems. Many of the tank parts manufactured by the corporation are constructed from aluminum and require advanced welding techniques.

Commercialization: Because the company is currently operating at only 60% of manufacturing capacity, they are currently looking to sell their services to the automotive and other heavy manufacturing industries. Although the president perceives the company as somewhat small to be inherently price competitive in this market, he believes that enough business can be found to keep the company in business.

However, he believes that the current trend in the automobile industry towards "partnering" between the automobile industry *per se* and its vendors as a significant barrier to Company C's entry into this market place. In sum, given that the major manufacturers in the automobile industry may have already selected vendors with whom to partner, that it may be too late for firms such as this to find a place in that particular market. In other words, time may have passed them by. Nonetheless, he believes that high quality firms such as Company C can benefit greatly from a

partnering environment which require a vendor geared more towards a quality product and timely delivery than pure price.

Reconstitution: Although a learning time of approximately one year might be needed to identify and qualify a firm for the production of the type of parts now being manufactured by Company C, based on the available evidence it seems reasonable to assume that such a vendor could be found relatively easily. Here it needs to be noted that this firm now manufactures a number of parts previously manufactured by Company B; that is to say, in light of this latter firm's stated intention to liquidate its business operations, General Dynamics moved the production of these parts from one vendor to another with no perceivable loss in efficiency. Based on this, it now seems safe to assume that reconstituting this portion of the defense industrial base may require no more than twelve to twenty-four months.

Company D

Product Line: Company D represents an anomalous situation in this survey inasmuch as it does not directly manufacture anything. Instead, they design, engineer, assemble and test the hydraulic accumulators and auxiliary tanks that they sell into the Abrams program.

Reflecting the turndown in defense business, the company has recently undergone a drastic reduction in force, and is now struggling to stay in business. Loss of the Abrams contracts will further weaken an already weak company, which does not now have the ability to diversify into commercial markets because of its lack of manufacturing "know-how" and its minimal investments in manufacturing equipment.

Reconstitution: Based on the project team's review of the type of products provided the Abrams program by this firm, it would appear that there are a reasonable number of large industrial firms capable of manufacturing the products now being supplied by it, that is to say, that there is a sufficiently large military and commercial market extant to otherwise guarantee that this element of the defense industrial base can be reconstituted if and when this is necessary, particularly if commercial standards can be substituted for military standards for a reasonable period of time.

Company E

Product Line: Company E is a vendor of various electronics components, that is to say, wiring harness, circuit card and electro-mechanical assemblies. It now makes 30 wiring harnesses specific to the M1A1 tank, 20 wiring harnesses specific to the M1A2 tank, and 30 wiring harnesses which are common to both tanks. They also make about 20 circuit card assemblies, half of which are no more than custom terminal strips. For all of these parts, their scope of supply is strictly built-to-print. Defense sales now account for approximately 50% of their annual sales base.

Technical Details: Company E maintains a relatively "low-tech" shop with the following equipment: solder stations, hair dryers (for curing shrink tubing), a large heat bed and two large ovens (for shrinking the tubing on large parts and curing the adhesive on some parts), a hot rivet machine,

and a small machine shop consisting of a lathe, a drill press, a milling machine, a band saw, and a small hand press. Productivity increasing machinery consists of two wave soldering machines and a semi-automatic component locator (a CNC machine which steps the operator through all of the locations on the circuit board where a given component is required, and then trims the leads on the back of the board).

This firm's testing shop has sufficient capabilities to automatically test the parts; all of the cables are tested on the same continuity tester using custom "personality harness." The machine checks pin-to-pin conductivity, checks for shorts and insulation effectiveness.

The circuit cards require more engineering to test; for each card, a custom testing box is built with about 20 or so independent tests of the components. Where required, vibration and underwater environmental testing is contracted out.

The level of labor force skills required by Company E are relatively low, with management reporting that its employees are paid about 10% less than the prevailing wage scale in competing firms in their geographical area. As a result of this, labor turnover rates in the firm are quite high.

Commercialization: As reported by management, the low skill level required to perform in this particular business, makes Company E especially vulnerable to a Federal law which requires that federal prisoners be given first preference on specific government-originated orders for the type of product that it now manufactures. Because of this, it has lost a number of contracts on which it was otherwise able to perform. In addition, management reported that it also lost government-originated business to federally subsidized Cherokee Nations companies. Because of these two factors, the company believes that it is under extreme pressure to trim prices and, hence, profit margins.

Notwithstanding this, Company E is currently operating at 90% to 95% of its manufacturing capacity. Moreover, this capacity could be doubled at minimal cost by adding a night shift. Current sales projections call for a sharp increase in civilian sales in order to compensate for the Abrams-based sales volume which is now scheduled to phase out by third quarter of 1994.

Company E's commercial products are much the same as those for the tank: cables (both conventional and ribbon), circuit boards, heat sink wiring assembly of fiche reader/printers, etcetera. In other words, this company is not faced with a conversion problem; its products are of dual-use in design and manufacture.

Reconstitution: Management notes that small businesses are beginning to lose interest in Department of Defense business because of its "feast and famine" nature. It stated that its loss of sales to the B-2 program presented it with a difficult business situation but that the existence of other aircraft programs provided it with business potential. Conversely, management regards the loss of the M1A1 (and M1A2) programs are especially worrisome because of the uniqueness of this program, that is to say, that there are no other tank programs available for which it can bid.

Management noted that it is not only the loss of defense business that hurts, but that the concomitant increase in overhead to be absorbed by commercial products makes competition in these markets even more difficult than it might otherwise be.

Company F

Company F is the American division of a German firm which purchased the division about 10 years ago. Company F's U.S.-based production force is divided between its commercial industrial balancing division and its defense technology division, with about 70% of revenues coming from the industrial balancing division and 30% from its defense division.

The industrial balancing division is one of the two largest manufacturers of custom industrial (as opposed to consumer) balancing equipment in this country. Carl Schenck AG, which owns Schenck Trebel in Deer Park, New York, is their largest competitor.

The defense division is currently in the process of becoming independent of the industrial balancing division, and the new division will most likely be renamed. This process will include moving to a new facility and replication of currently shared administrative centers. Because the defense division currently operates as an independent division, and will soon be an independent business unit, our discussions are confined to this division.

Product Line: Company F currently sells four related parts for the M1A1 and M1A2 tanks: a sixteen-round ammunition rack, swing frames for this rack, a two-round ammunition rack, and a six-round hull rack. Although this firm performs various levels of efforts on these parts, about 75% of the manufacturing is performed by their German parent company. Company F does CNC machining, and welding (MIG and TIG) of some sub-components, and performs the final assembly, inspection, and shipment of all parts.

Technical Details: This company has a modern machine shop, with a number of pieces of high tech equipment used to build military technology products: a horizontal CNC milling machine, another horizontal CNC milling machine with a head that can pivot up to a vertical position, a CNC lathe (which is also used for commercial work), a manually operated NC drill, and a CNC automatic inspection machine. Both of the CNC milling machines are made by Maho, a German company. Other equipment includes conventional milling machines (large and small), drill presses, belt sanders, manual TIG and MIG welding stations, and a large pickling bed for cleaning aluminum and steel raw materials in accordance with the governing Mil specs. The vendor characterizes his shop as batch mode production, rather than assembly line or job shop. A significant investment in fixturing and automated equipment programming is required for the first part, while all subsequent parts can be made much more cheaply and easily.

The technical skills required to perform in Company F's shop are moderately high. The required welding skills are above average, as are the assembly skills, due to the complexity and relatively close tolerances of the ammunition rack assemblies. The initial programming of the CNC machines to perform the automated steps required a high level of skill and trial and error; a new vendor would

require two to three years to begin to make acceptable parts. Company F's pay scale is characterized as slightly to significantly higher than other local shops, so turnover has not been a problem.

Commercialization: By design, Company F is structured to be defense contractor. Their experience and structure are both geared toward this market segment, and they see no compelling commercial markets to draw them out of the defense market. As management points out, the loss of the M1 to M1A2 conversion program will have a great impact on the company's future since the company is currently 100% dependent on the M1A1/M1A2 contract. However, the firm does have a number of large defense contracts, and the parent company appears to be willing to support the division for some period of time, into the future.

Reconstitution: This company is in an unusual position because its parent company created the basic design of the ammo rack assemblies and sold DoD on the concept. Company F was awarded a sole source contract to make the parts, and the latest contract ends in April 1994. Further, management anticipates renewal of this contract, but is also working to develop new contracts as the defense division is currently only at 25% of manufacturing capacity. Company F and its parent company have developed three products they are trying to sell: a Barrel Insert System, a Through Sight Video (TSV) System, and a Grenade Launcher System. The Barrel Insert System is a training device which replaces \$800 120 mm shells with modified 35 mm shells that have the same recoil and flight characteristics as a 120 mm shell for short and medium range shots, at a cost of \$80 per shell. The TSV System is a recorder which creates a record of the training mission which can be used for later analysis. Company F perceives a large market from countries (such as Korea and Malaysia) which like the military technology which has been developed by Germans. For these reasons, which do not believe that the reconstitution issue is, or will be, a problem for it.

Company G¹⁷

Company G, a division of a major U.S. firm, is organized into two business sub-groups. One of them manufactures lightweight armored vehicles and turrets, the other, the respondent division, is the focus of this discussion. This segment of the Company G is a "world leader" in the weapon/turret control system market and produces control and stabilization systems both for U.S. and foreign-made battle tanks. Although the Honeywell Corporation was once active in this market, Company G is today the sole producer of this product in the United States. Were it to exit the market, its departure would leave a significant void in the subcontractor base now used by General Dynamics, the tank's prime contractor. In addition to its high technology manufacturing capability, this firm owns a number of proprietary rights to the product's design as well as knowledge critical to its production. Because much of the process required to produce the system is, in management's opinion, more "art than science", transferring this knowledge to a potential source would be both time-consuming and expensive. Based on our observations and the data provided us, a period of two or more years might well be required for this transfer of technology were such a transfer deemed essential.

¹⁷ Because of the critical content of the products manufactured by company G, the report format used for other contractors will not be used here.

Part of this reflects that the initial concept development phase for the weapon/turret stabilization system now in use on the Abrams tank began in 1958. Following on with this initial capability and its subsequent development activities, Company G became a member of the General Dynamics/Abrams Tank team in 1973. Because (a) of the criticality of the control and stabilization system that it manufactures, (b) the technological background, manufacturing equipment and labor skills needed to produce the product and (c) the lack of any potential competitor for the products that it now provides the Abrams program, this firm will remain an integral part of the Abrams program for the foreseeable future. However, and despite its position as the manufacturer of a highly sensitive military system, it is anticipated that the division's sales volume will drop from a 1988 peak of approximately \$95,000,000 to an estimated \$30,000,000 by 1994.

Since the presently planned final phase-out of the Abrams program is scheduled for 1994, the company has prepared no sales or manufacturing forecasts for subsequent years. With the possible exception of some limited use of its extensive manufacturing facilities in Ohio, Company G is presently unable to make any definitive plans for its future as a business unit. Moreover, in the opinion of management, the company does not have the option of converting to commercial production because of its lack of core knowledge in the commercial arena and because of the solely military applications of the skills and technologies that it now possesses. Despite this, some marginal uses may be made of the manufacturing capabilities of the company's high technology, capital intensive Ohio facility. The potential for the use of this facility by other divisions of the parent company was not discussed.

From a design, manufacturing, and testing perspective, the skills required to make the weapon/turret control system can generally be categorized as "high-tech." Because of the extremely tight tolerances required on many of the parts that make up the system, and because of the need to systemically integrate complex electrohydraulic and electromechanical sub-systems into the final product that it manufactures for the Abrams tank, it is management's view that there is oftentimes more "art than science" required in the manufacturing and systems integration process. Moreover, management maintains that much of the "art" required for these critical components cannot be captured in any technical data package; that the success of their manufacturing and test procedure is highly dependent on highly skilled labor force trained to their tasks over the past eight to ten years. Here it should once again be noted that the initial development of the control system began in 1958, and that the product now being manufactured by Company G evolved over a number of years.

No analysis was made of the manufacturing equipment in place in the Ohio facility inasmuch as the transfer of equipment from Company G to Ohio facility had not yet been completed. However, of note here is the \$21,000,000 investment made in both of these facilities, of which in excess of \$15,000,000 is accounted for by manufacturing related equipment, a relatively sizeable sum when measured by the current and projected sales base of the division.

As noted earlier, Company G is a division of a major U.S. corporation which, in its turn is one of the United States's largest defense contractors. Its unconsolidated 1991 sales were in excess of \$6.0

billion, of which some forty-four percent is attributable to defense production, primarily in the aerospace and technology areas. In recent years, it has ranked consistently among the top 10-15 largest defense contractors in the United States. In some instances, it is the designated prime contractor for a major program. As a major producer of weapon systems and their components, the parent company can expect to see its sales base shrink over the next few years. Given its inherent financial strength, however, and its position in various commercial markets, the overall firm should be able to adapt to these changes. Specific analyses, however, would have to be made at the divisional level to determine the future of many of these defense-related business operations.

Company H¹⁸

Company H, with sales of approximately \$1.0 billion per year, is a division of a Fortune 500 company with total consolidated sales of \$4.1 billion in 1991. Neither the division nor the parent company are sufficiently dependent on defense procurements to allow them to be categorized as a defense contractor, or even as a major supplier to the defense industries. Company H's management estimates that no more than 5% of its final output is purchased either directly by the Department of Defense or by various defense contractors and subcontractors.

The Company H's prime business is bearings and bearing-related equipment. They are today the largest independent producer of bearings and bearing-related products in the United States and, possibly, in the world. Given their extensive commercially oriented business base, the problem of conversion as it has been defined in this project is not relevant to this firm. This company will remain in the bearing industry and, given the inherent competitiveness of the industry, be required to maintain both its technological and production capabilities. In other words, the proposed reductions in future defense budgets will have no significant impact on the viability of the firm, or its continuing ability to meet defense needs as they arise.

This last remark is, however, subject to one caveat. In management's opinion, the primary threat to this firm's continuing ability to meet the product quality standards mandated for defense production can be found in the current inability of the United States steel industry to produce the quality and quantity of steel normally required to produce the type of bearing required in the production of highly sophisticated defense equipment. Management alleged that the Company H was currently dependent on foreign sources for some types of high quality steel, and that they expected this dependency to increase in the foreseeable future. Of somewhat equal concern to management is the current state of the domestic machine tool industry. Specifically, they noted that United States no longer has the domestic capability to manufacture or otherwise assemble the equipment needed to build a modern steel mill; that this capability had migrated overseas such that there were critical but unrecognized international dependencies of significance to Company H, and other producers of steel and/or steel-based high technology products.

¹⁸ Because this company cannot be classified as a defense contractor, no effort has been made to fit the data on this firm into the reporting format used for the other firms surveyed as part of this project.

Because this last issue is beyond the scope of this project, no effort was made by the project staff to verify management's contentions. However, a second instance of foreign dependency was noted by Company A. According to this firm, there is only one domestically-based manufacturer of military quality optical glass in the United States. Moreover, this firm is the U.S.-based division of the Zeiss Corporation of Germany. Its primary competitor in the United States is Ohara, a Japanese firm with warehousing facilities in California.

Recapitulation: Commercialization

With the exception of Company D, all of the smaller firms that we visited have a job shop-oriented production floor, and do not have significant investment in custom machines for making tank components. Therefore, the conversion of their production capabilities to commercial products is not a technical but a business problem. This, however, assumes that they have sufficient modern machinery to be able to produce commercial goods at a cost which allows them to effectively compete in these markets.

In point of fact, approximately half of Company A and Company E's annual sales volume comes from the production of commercial products and it seems reasonable to assume that they will increase this proportion as their defense contracts wind down. What is not known, however, is how profitable they can be in these markets; whether they can attain the type of cost efficiencies that allow them to earn a reasonable profit on their commercial output. Clearly, the management of each of these two firms believes that this is possible assuming only that general economic conditions are conducive to their respective efforts.

Although Company C has never, or at least not in recent years, been a commercial producer, given its significant investment in CNC machines and the technical skills of its management team, it seems reasonable to assume that this firm will be able to position itself in this market within the next one to two years. Once again, this latter statement assumes that general economic conditions will be buoyant enough to

allow Company C to develop profitable commercial products. This last statement, however, applies to all firms, whether or not they be in the defense industry.

Based on our analysis, both Companies B and D will not survive the transition from defense to commercial production. The reasons for this conclusion are somewhat self-evident: Company B's had begun to liquidate its business for reasons which the research team did not see fit to explore. Company D appears to be doing the same thing but, in this regard, it needs to be noted that they are a "design and engineering" as opposed to a production shop. Based on our observations, it seems evident that their business was dependent on the assembly of products in which they had proprietary rights and that the market for their services has now diminished substantially.

For all of these smaller firms, one of the main impediments to entry into commercial markets is the increasingly global nature of the manufacturing process and the fact that a number of erstwhile foreign competitors have both lower labor rates than their American counterparts, and are more heavily invested in state-of-the-art manufacturing equipment, both of which lower their unit cost of manufacturing. Given the relatively small size of the U.S. firms included in this survey, these factors can serve to make the smaller U.S. firm less than competitive in today's market place. Therefore, if at all possible, these firms will need to grow, make additional investment in equipment, and find customers who value quality and timely response over price. In this regard, Companies A, C, and E are

likely in a strong enough position financially and technically to survive the loss of their M1A1 contracts. Companies B and D, as noted above, are most likely not.

Company F is, of course, a special situation in that it has stated that it intends to remain in the defense business, building on the strengths of its parent company in Germany. Indeed, management believes that as the U.S. small business defense industrial base diminishes in size that the number of business opportunities available to it will increase. Given the backing of their German corporate parent, their business plans for the future seem reasonable.

Conversely it seems reasonable to assume that the Company G will be forced to close down its operations within the next two to three years. The reasons for this are, in management's view, straightforward. As a major, dedicated defense firm, they have neither the marketing skills nor the equipment needed to compete in commercial markets. However, what ever demand that may still exist for their products can most likely be met by the parent company, that is to say, there may not be a complete loss of this firm's technological capabilities.

Inasmuch as Company H is only peripherally involved in the defense production arena, no further comment on this firm appears essential at this time.

Recapitulation: Reconstitution

Inasmuch as all production on the Abrams tank is now scheduled to end in 1994, with both the Detroit, Michigan and Lima, Ohio tank manufacturing and assembly facilities placed on a stand-by footing, one of the key question that was to be addressed in this project is the ability of the vendor base that otherwise supports these facilities to resume production should the need arise. In order to resume production, one must preserve the ability to produce the components which are most difficult to learn to manufacture.

This is especially true for those components which act as "force multipliers," giving the weapons system some competitive advantage over competing military systems. Because General Dynamics holds the Technical Design Packages for all of the components these vendors manufacture, technically speaking no engineering know-how will be lost if the smaller firms go out of business. However, it should be pointed out that the components made by these vendors in some cases took a couple of years to learn to make properly, with associated investment in manufacturing engineering and custom fixturing. Thus, reconstituting the supplier base could take from two to four years at minimum.

Based on discussions with Company A's management, it appears that the domestic precision optical industry is small and fragmented. Where once there were several companies of about 100 employees making these products domestically, Company A is now reported to be the giant of the domestic industry with about 100 employees. Some of the components made by Company A for the tank can be considered moderate force multipliers, because they need to be of high quality for the proper operation of high-tech devices such as laser targeting equipment and eyepiece assemblies. The loss of Company A would have a definite impact on the ability to produce these sorts of components domestically.

Both Companies B and C manufacture parts which, in and of themselves, are not critical. The commercial market for their services is large domestically. Companies such as FMC, Caterpillar, Cummins Engine, and the major automotive manufacturers support this industry and have similar capabilities themselves. Therefore, even if both of these vendors were to go out of business, their capabilities could be replaced, although it may cost several million dollars and take 2 to 3 years to fully resume production at previous levels.

Company E manufactures components which require very little skill and empirical knowledge. Therefore, the components made by this firm can rather easily be made by the other vendors in that industry, or a new vendor could be created in less than a year. The loss of Company E will have no impact on domestic surge capability.

The components manufactured by Company F are moderate force multipliers and are somewhat complex and difficult to manufacture. Furthermore, no other vendor has attempted to manufacture the components which were designed by Company F's parent company, so the degree of difficulty for another vendor to make the part is unknown. Assuming that GD has all of the design information required for the ammo racks, it should be possible for another vendor to begin volume production after about 3 to 4 years and several million dollars of development effort. Nonetheless, it should be noted that the technology used to manufacture the ammo racks is not particularly unique, and appropriate replacement facilities may exist. Loss of Company F will cause interruption in our ability to make ammunition racks for tanks, but not a permanent one.

Summary

One outcome of the projected down-sizing of the defense budget is already obvious. The defense-related sales of virtually all of the firms in both the defense industry and in the defense industrial base will decrease, albeit not equally. Given a certain and relatively predictable decrease in sales, the key question then to be answered is how the individual company will adapt to these reductions. To this question, there is no one easy answer.

First, without a growing economy, conversion to civilian production will be difficult if not indeed impossible for most smaller defense firms. Thus, there is the potential for the permanent loss of certain key manufacturing capabili-

ties in the United States, losses that might well impede the reconstitution of specific facets of our defense production capability should the demand for this capability ever again be voiced.

The question might well be asked here why, as a nation, we were able to accommodate a significant reduction in the defense industrial base in the 1970s, but then rebuild, or otherwise reconstitute, that base when it became essential in the 1980s. The answer to that question is quite complex, and is interrelated with a whole series of past political and economic realities.

To begin with, there was no perception in the 1970s and 1980s that the military threat to the United States had diminished to the point where it could afford to disassemble its defense research, design and production capability. In the 1970s and 1980s, it was obvious politically, and hence economically, that we would have to continue to devote substantial sums of money to the development and fielding of new, technically astute military technologies. From industry's perspective, it was a question not of the sums of money that would be spent, but the time periods in which this money would be spent. As such, industry had a direct incentive for remaining involved in the defense effort.

Adding weight to this perception were the substantial sums of money being devoted in the early 1970s to preliminary and secondary research on new weapon systems. Among many others, the Abrams tank, the Patriot missile, and the F-16 fighter aircraft were then in the preliminary development and/or production stage. It was rightfully assumed by industry that there would be economically viable production runs of these and other military platforms such that maintaining both the intellectual property and manufacturing capability side of the defense industrial equation was economically logical and feasible.

These self-same political perspectives do not now obtain. It appears now that the proposed reductions in the defense budget are to be a permanent feature of our economy. To wit, that there will be a permanent reduction in the number of firms and persons for whom the defense budget otherwise provides an economic rationale. That being the case, it should be assumed that there will be a slow structural rationalization among the industries, firms and persons that have heretofore relied on the defense budget for sales income, profits and jobs. In sum, the current reduction in the size of our military industry can be expected to take place in a far different historical, economic and social context than did the reductions in the post-WW II and Vietnam periods.

Thus, the response to the down-sizing requirement will vary from company to company based

on management's assessment of a broad, and sometime indeterminate, set of factors. Driving the process will be such management and economic factors as the capital base of the firm, its core business capabilities, the business and technical background of the firm's senior managers, and the corporate culture. These factors vary significantly from company to company as does their interpretation. Some of the managers with whom we met were admittedly confused as to how they should respond to the projected down-sizing; others appear to have begun to take aggressive action to find new product and marketing niches for their companies. In addition, these responses varied according to the size of the firm, its ownership and whether it is a *defense industry* or a *defense industrial-base firm*.

THE U.S. TANK INDUSTRY

In terms of its size, the United States tank industry has never been a significant employer. As shown in Exhibit I, on the following page, employment has ranged from a low of 8000 people (1965) to a high of 22,000 (1983), the last year for which data of this type is currently available. In light of the subsequent build-up after 1982 of the Abrams program, it seems reasonable to assume that direct employment within the industry may have increased to as many as 30,000 persons.

Direct levels of employment in an industry, however, can be misleading. This is particularly so in the tank industry, since, as shown in Exhibit I, material costs as a percentage of sales income have consistently accounted for between 55% to 65% of each dollar of sales income. In other words, at the prime contractor level from which these figures are derived, tank production is more of an assembly and/or sys-

tems integration than a manufacturing process. The bulk of the manufacturing is accomplished outside of the prime's facility, a "fact" verified during field trips that are the central focus of this report. In economic terms, then, tank production is a low value-added process at the prime contractor level, although the opposite may be true at the various lower industrial tiers.¹⁹

Two additional factors can also serve to distort the data about underlying relationships in an industry: (1) the use of government-furnished equipment (GFE) in the final assembly of the tank, and (2) the fact that the assembly operation is accomplished in a government-owned but contractor-operated facility (GOCO). If the relevant data on the various costs underlying the government's purchase of systems, sub-systems and components for inclusion in the tank is *not* added into the sales base reported by the prime, there is then a significant understating of the

¹⁹ The same low value-added content obtains at the prime contractor level in Germany, albeit for different reasons. See Chapter 5 of this report.

United States Trip Summaries and Analysis

TANKS AND TANK COMPONENTS

Payroll

Years	Workers (1000)		Payroll (\$ Mill)		Payroll per Workers		Total Labor Force
	Prod	Non-Prod	Prod	Non-Prod	Prod	Non-Prod	
1983	15	7	345	235	23000	3571	.682
1982	13	5	290	184	22308	36800	.772
1981	11	3	222	106	20182	35333	.786
1980	10	3	199	85	19900	28333	.769
1979	11	2	171	63	15545	31500	.846
1978	11	2	167	58	15182	29000	.846
1977	10	2	156	53	15600	26500	.833
1976	8	2	111	35	13875	17500	.800
1975	7	1	86	27	12286	27000	.875
1974	5	2	76	28	15200	14000	.714
1973	5	1	55	20	11000	20000	.833
1972	5	1	47	18	9400	18000	.833
1971	5	2	45	27	9000	13500	.714
1970	5	3	46	30	9200	10000	.625
1969	6	4	58	32	9667	8000	.600
1968	9	4	72	37	8000	9250	.692
1967	10	3	68	33	6800	1100	.769
1966	7	3	50	23	7143	7667	.700
1965	5	3	34	22	6800	7333	.625
1964	8	3	37	26	6167	8667	.667
1963	8	3	48	29	6000	9667	.727

As a Percentage Of Sales

	Direct Labor	Material Costs	Overhead Costs	Indirect Labor	Loaded Direct	Total Labor
1983	10.09	62.39	27.52	6.87	37.61	16.96
1982	12.37	64.12	23.51	7.85	35.88	20.22
1981	13.3-	49.88	36.73	6.39	50.12	19.78
1980	914.02	60.75	25.23	5.99	39.25	20.01
1979	16.60	58.06	25.34	6.12	41.94	22.72
1978	15.28	57.46	27.26	5.31	42.54	20.59
1977	16.70	63.17	20.13	5.67	36.83	22.38
1976	15.42	64.86	19.72	4.86	35.14	20.28
1975	17.06	55.56	27.38	5.36	44.44	22.42
1974	20.99	53.87	25.14	7.73	46.13	28.73
1973	17.08	58.39	24.53	6.21	41.61	23.29
1972	17.28	55.15	27.57	6.62	44.85	23.90
1971	13.04	56.23	30.72	7.83	43.77	20.87
1970	12.78	57.78	29.44	8.33	42.22	21.11
1969	13.74	56.64	29.62	7.58	43.36	21.33
1968	14.24	65.81	19.96	7.31	34.19	21.54
1967	17.26	66.75	15.99	8.38	33.25	25.63
1966	18.25	56.93	24.82	8.39	43.07	26.64
1965	15.45	52.73	31.82	10.00	47.27	25.45
1964	12.46	71.72	15.82	8.75	28.28	21.21

Exhibit I. Payroll and Cost Factors as a percentage of sales.

number of employees and economic resources used in the manufacture and assembly of tanks. Given that major portions of the tank were furnished on a GFE basis—the engines for example—it is possible that the direct employment levels in the industry are understated in Exhibit I by as much as 50% as, potentially, are the relevant costs and the underlying constituents of these costs.

Producing military equipment in a GOCO also leads to a systematic understatement of the resources used by the prime contractor. For example, the prime's costs and, hence, the price charged the government does not include the cost of, and the relevant depreciation either of the physical facility or of the government-owned machinery and equipment in the plant. To the extent that these costs are substantial, and to the extent that government paid labor is used to maintain these facilities, either partially or in their entirety, there is once again a systematic understatement of the resources devoted to tank production. Parenthetically, this is not to suggest that a GOCO operation is anything less than efficient but only that the resource base recognized by the relatively conventional economic data collected by the Department of Labor may systematically understate the economic resources devoted to the production of various weapon systems.

The final factor that can also distort the data on the overall effect of tank production on the economy is related to what the military refer to as "force multipliers." These are extremely

high technology systems or sub-systems integrated into a weapon system that give it a desired advantage in its war-fighting capabilities. In the instance of many weapon systems, aircraft and naval combatants being the prime cases, the costs of these systems far outweigh the costs of the platform, *per se*. Of significance here is that these high technology systems are rarely manufactured by the prime. In point of fact, most of them are produced in the electronics, computer and related industries. The prime, however, is responsible for integrating them into the platform, but at a cost which is only a minor proportion of the total cost of the platform.

For example, the Navy's Aegis cruiser costs more than \$1.0 billion to produce. Of this sum, only about 30% is accounted for by the platform as such. The bulk of the cost, and the accounting for it economically, shows up in the electronic and related industries. To a reasonably similar extent, the same is true of the Abrams program although, given its size and configuration, it is likely that the final percentage of the cost of an Abrams tank attributable to force multipliers is less than that of other platforms.

Inasmuch as these cost realities are not central to the analyses that are of prime interest to this report, no detailed investigation was made of these matters. However, an understanding of these factors is pertinent to the overall analyses directed at determining the various effects of down-sizing in the defense industries.

Chapter 4

CONCLUSIONS ON

RESEARCH METHODOLOGIES

As outlined in the first chapter, one of the major goals of this project was to make judgments about the types of research methodologies that are needed to realistically determine the impact on the U.S. defense industrial base of continuing reductions in the defense budgets. In order to accomplish this, a number of questions were posited in order to structure the research effort, among them:

1. Having reduced the levels of employment in the defense industry substantially with a consequent loss of many skilled workers, can the industry be "reconstituted" in a timely fashion to meet an emergent military threat?
2. Having reduced the size of their defense-oriented operations, is it possible for the defense firm to replace lost defense sales by "converting" to civilian production? Lacking this ability, is corporate survivability a critical issue for many of these firms and, especially, the small-scale firm?
3. Is it possible to maintain the core capabilities of the defense industry during what may well be a long-term down-sizing period? In this regard, core capabilities are considered to be (a) an adequate supply of properly skilled workers who can provide the skills basis for a timely increase in production, (b) adequate machinery in sound operating condition to meet production demands, (c) sufficient knowledge of the production and test procedures to produce the required military equipment and, (d) a management team fully knowledgeable with adequate, if not complete, knowledge of the acquisition process.

To some extent, these matters have been discussed earlier in this report and *tentative* conclusions drawn where the data seemed adequate. However, what has not yet been discussed is a research methodology that might allow for more accurate answers to some of the above questions.

In this regard, given the size of the defense industrial base, we do not believe that there is any *specific* research methodology that can adequately answer all of the above questions. The problem here is the traditional one of far more data than can possibly be collected and analyzed. For example, GDLS relies on more than 4,500 suppliers for the final assembly of the Abrams tank. Conceivably, an analyst could survey each of these 4,500 firms and do a credible analysis of how they will adapt to the down-sizing. However, the time and resources needed for such an effort would be massive, and the results would no doubt be outdated by the time the report was written.

Moreover, the impact of the down-sizing on these 4,500 firms would, in all likelihood, have ripple effects on the supplier base of these 4,500 firms, or at least another 20,000 to 25,000 as yet unidentified firms. Research-wise, then, the task is formidable if not, indeed, impossible if thoroughly comprehensive answers to the down-sizing problem are required. Because of this, we believe that an *alternative approach is needed*.

Based on our efforts, we are now convinced that two forms of defense industrial base research are essential. We have classified these as

“Force Multiplier” research and “Product Line” research. Each of these is discussed below.

Force Multiplier Research

By Force Multiplier research, we mean investigations limited to those items of the weapon system which, *in the opinion of the military user*, are critical to maintaining its combat superiority. In other words, we now believe that defense industrial base research should be focussed on those firms who are responsible for the design, development and production of the force multipliers, as they are defined by military doctrine.

From a research perspective, this would not only limit the amount of data that needed to be collected and analyzed, but it would allow for a subsequent analysis of the industrial resources needed to maintain the war-fighting superiority of U.S. produced weapon systems.

Procedurally, the research effort would require that the various users of military equipment specify for each of the various weapon systems under their command the specific system, sub-system or component that provides that system with a superior war-fighting capability. Here there would have to be some knowledgeable trade-offs inasmuch as the number of systems to be investigated would have to be kept reasonably limited. However, once these selections were made, a detailed investigation of the firms involved in the production of these specific systems could be made, and reasonable assessments about the future of the industry and companies within that industry developed as the basis for any special action that might then be taken to protect the required manufacturing base.

For example, we have been lead to believe that the weapon/turret control system manufactured for the Abrams tank by the Company G fits into this category. If our belief is correct, then a detailed investigation of the company, the sup-

plier base on which it relies, and how this specific capabilities can best be maintained should be made. This more limited research is doable and can (a) be accomplished on a timely basis and (b) be routinely up-dated. Similar efforts can then be made for other systems, sub-systems and parts that are critical to the effective war-fighting capability of the system. *The criteria for the research and its scope, then, would be based on the needs of the military community and, as such, would be “consumer-oriented” research of immediate value to the acquisition planning process. In particular, the research could contribute to the preparation and up-dating of the acquisition strategy document required annually of all program managers. The research approach suggested above, then, is a technology and company-specific approach to answering the questions discussed earlier in this report.*

Product Line Research

By product line research, we mean industry level research focussed on those industries that are most apt to suffer significant declines in sales volume and manufacturing capabilities as a result of the down-sizing of the defense budget. The basis for their initial identification should be the results of the Force Multiplier research.

For example, as the prime contractor for the Abrams tank, GDLS relies (as do a number of its vendors), on what might best be defined as the machine shop industry. Based on an admittedly limited set of data, it seems reasonable to conclude that this is an industry dominated by small and not always well-financed firms. As our limited evidence suggests, a number of these firms may fall by the wayside as a direct result of the down-sizing process. Moreover, given the globalization of many manufacturing industries and the internationalizing of much of the vendor base of the defense industry’s large-scale prime contractors, there is little likelihood that the industry will maintain its inherent core

capabilities in the foreseeable future. If this contention is correct, then data on this industry needs to be developed and maintained both centrally and at the Program Manager level.

Of utmost concern here may be maintaining an up-to-date listing of contractors and potential contractors with *both the capital equipment and the skills* needed to phase into high-quality defense production if the need arises. Given that the Department of Labor, the Department of Commerce and industry associations maintain data of the type needed, developing and maintaining a database on a limited number of industries and the companies within this industry may not be as complex or as time consuming as now thought. However, until an initial investigation of at least one industry is made, no final conclusions on the scope and content of the required research can be made.

In addition to the above, and admittedly based on our discussions about raw material supply with executives of both Companies A and H, specific research needs to be mounted at the raw material level in order to determine if the large size of these basic industries hides the fact that they no longer, or may shortly be unable to act as a domestic source for military quality raw materials. In this regard, we have been lead to believe that there are critical supply deficiencies in both the U.S. steel and high quality optical glass industries. Given the scope of this project and the professional background of our respondents, no effort was made to determine the correctness of the information. We simply accepted the information as being correct.

Once again, industry associations and certain governmental agencies collect and maintain much of the data needed for analyses of this type. However, as with all information of this type, it should be maintained centrally at the DOD and at the appropriate Program Manager office.

The Defense Economic Impact Modelling System (DEIMS)

In order to clarify some of our thinking on research methodology, we reviewed a number of data bases and in particular DOD's Defense Economic Modelling System (DEIMS). Our primary concern here was with determining if it were possible to limit the product line research to a relatively modest number of industries.

Based on a review of the data collected by DEIMS, and even assuming that there are a number of understandable defects in the research design, we are firmly convinced that product line research can be confined to a limited number of industries, perhaps ten in all.

The basis for this judgment represents our interpretation of the DEIMS derived data presented in Exhibit II (on page 38). For example, for Industry Code 333, direct and indirect purchases for 1991 were calculated to be \$36.8 billion. Between now and 1997, they are calculated to drop to \$30.2 billion. Although this is a large drop sales-wise for the industry, given the size of the industry, it seems reasonable to assume that the industry will retain whatever actual or latent capability that may be needed by the Department of Defense. This is not to suggest that some firms may not exit the industry, but that the industry itself will remain vital enough to meet any and all of DOD's requirements in the predictable future. Moreover, if the industry itself has some supplier base problems, these should be easily identified by working with the various associations that represent the industry nationally.

Similarly, a review of the data for Industry Code 351 suggests that any *direct* analysis of the industry's forecast ability to meet future DOD requirements need not be done except, possibly, on an ad hoc basis. However, as the body of our research suggests, there *may* be future problems in the domestic vendor base on which this industry relies, specifically the machine shop in-

Conclusions on Research Methodologies

dustry. However, this industry is a vendor base for a number of other defense related industries such that any basic research done on the machine shop industry should be applicable across the broad spectrum of defense procurements. The same level of potential dependency on this smaller, more fragile industry may also be found in a review of the Aircraft Engine and Aircraft

Parts industry although we are now loathe to make any judgments here.

Conversely, we would hazard the informed guess that some focussed research on Industry Code 336 and Industry Code 361 may be in order. Contrariwise, we doubt that capabilities-oriented research needs to be done for the computer industry, Code 303, the computer and data

INDUSTRY & CODE	PROJECTED DEFENSE PURCHASES (Millions of 1990 dollars)		DEFENSE AS A % OF SALES (Projected)	
	1991	1997	1991	1997
Aircraft	351	16,427	14,538	28.08
Electronic Computing Equipment	303	3,492	3,306	5.09
Radio & TV Communications Equipment	333	36,838	30,169	40.17
Tanks and Tank Components	52	2,501	491	
Blast Furnaces and Steel Mills	223	4,599	3,083	6.74
Iron and Steel Foundries	228	693	477	3.39
Iron and Steel Forgings	229	505	329	6.29
Sheet Metal Work	254	537	437	14.49
Guided Missiles	50	14,792	11,466	4.68
Screw Machine Products	257	1,249	1,001	
Machine Tools, Metal Cutting	282	769	576	11.25
Special Dies, Tools, Accessories	284	1,450	1,117	11.11
Ball and Roller Bearings	295	453	347	8.90
Electronic Measuring Instruments	312	1,912	1,378	7.93
Semiconductors	335	4,112	3,303	16.15
Electronic Capacitor	336	431	330	7.99
Aircraft Engines	352	7,049	5,082	18.26
Aircraft Parts	353	11,553	8,950	24.03
Engineering and Scientific Instruments	361	3,099	2,381	37.08
Computer and Data Processing	403	7,674	7,212	35.52
				4.96

Exhibit II. (Source: DIEMS)

processing industry, Code 403, and others not included on the short list presented in Exhibit II.

Summary

Our findings on research methodologies can thus be summed up as follows:

1. Macro-economic research on the defense industrial base will have a limited pay-off only for the DOD decision-maker inasmuch as it can only be primarily to predict the loss of jobs in specific industries. Because of the diffusion of the manufacturing base on which the defense industries rely, this type of research will not identify the potential bottlenecks to a reconstitution of all or even a part of the defense industrial base. Moreover, by its very nature, macro-economic research does not either investigate or analyze the environmental factors to which an industry's executive responds, and it is this managerial level response which is critical to any assessment of the short and long-term adaptability of an industry to economic change.
2. To be valuable, we believe that research should be customer-focussed. It is for this reason that we have suggested that the military user should be asked to set the requirements for the research. The purpose of our

various acquisition programs is to maintain military superiority consistent with an overall military doctrine. Thus it is the military user who should specify the focus of any military-based economic and industrial research. This research would then form the basis for user/producer discussions and decisions. Ultimately, this data could form the basis for budgetary requests based on a consensus as to the level and the scope of industrial support needed to insure a successful reconstitution-oriented program.

3. As suggested above, the various research efforts needed to make judgments on the viability of the defense industrial base should be highly focussed, limited scope efforts with every effort made to include already knowledgeable industry and government actors in the research. Ultimately, it is industry that has a best handle on the problems that it faces and knows best how to describe the research needed to clarify the problem and point out a potential solution to the problem if one exists. Any defense industrial base research of the type that we are recommending should rely heavily on statements of the problem set forth both by the user and producer of the military equipment. In this regard, we are convinced that substance is far more important than research design.

Chapter 5

GERMAN TRIP

SUMMARIES AND ANALYSES

Report of the Kiel Institut für Weltwirtschaft

One of the major responsibilities of this research project was to compare the structure, organization and operations of the German to the United States defense industrial base in order to make tentative assessments on how each of these economies will adapt to sharp reductions in each of their respective defense budgets. Of particular concern was the ability to develop a reasonable assessment of the "robustness" of the German economy, that is to say, the extent to which lower defense spending will, or will not, disrupt the long-term viability of the German defense industrial base.

In order to address this issue adequately, senior staff members of the *Kiel Institute of World Economics* were commissioned to conduct an investigation of specific elements of the German defense industrial base using a German adaptation of the research protocol previously used in the United States. The complete report prepared by the Kiel team is presented in Volume III of this report. Chapter Two of this report, "Results from the Field Research on Leopard-2 Manufacturers," follows.

Before reviewing this report, a number of preliminary comments on German industrial structure are in order. For example:

1. There is no readily identifiable defense industry in Germany. The reasons for this are both political and economic. After WW II, for example, the Germans were prohibited from rebuilding their defense industries under the terms of the various peace treaties that

brought the war to an end. For obvious political reasons, the German Government has preferred since then to limit the visibility of the defense industry that supports their military establishment.

Moreover, there are virtually no firms in Germany for which defense production accounts for more than a limited portion of the firms' total sales revenues. One on hand, this is a natural outcome of the size of the German defense budget. On the other hand, it is an outcome of the time needed to reconstitute the German defense industrial base once this became legally possible.

More critically, this outcome also appears to be the result of policy decisions made by a large number of corporations that are otherwise involved in the design, development and production of major weapon systems. The size and vitality of their commercial markets have been of sufficient size to allow them to limit their dependency on defense production.

2. Notwithstanding this, after 1987, the German defense industry began to restructure itself in recognition of significant post-1983 scale-downs in the size of the German and other European defense budgets. Most pointedly, the outcomes of this restructuring process has been the creation of a number of pan-European joint ventures sized to operate efficiently in a predictably smaller marketplace. This rationalization process was undertaken

solely by private industry with no overt governmental involvement in the various negotiating processes.

3. Part of the motivation for the structural rationalization of components of the European defense industrial base can be found in the European belief that these pan-European joint ventures will provide two specific types of "spill-over" benefits.

One, European corporate executives, and the Germans in particular, believe that a continuing involvement in the production of major weapon systems provides a vehicle for developing the type of "systems integration" capability that is the hallmark of the large-scale U.S. defense contractor. In the instances of key elements of the German industrial sector, management believes that this skill is essential to the future vitality and world-wide competitiveness of the European industrial sector.²⁰

Two, given the growth in military importance of "dual-use" technologies, the managers of a large number of large-scale German firms believe that defense production can be used as an economically rational vehicle for the development of technologically-based transfers of product knowledge and manufacturing "know-how" to its otherwise commercial divisions. Although this view is not widespread in German industry, it is a view that is nonetheless held by a significant number of the large-scale firms in the country.

4. Consistent with (3) above, German management apparently believes that the integration of East in the West Germany opens up a market for some of the skills and products previously developed by the defense-oriented divisions of their companies. Specifi-

cally, they believe that these skills have applications in the environmental area, and that the application of these skills require a stronger base of systems integration experience and knowledge than they now possess.²¹

Technical Issue: The Sample of German Firms

Potentially, there is a critical difference between the sample of U.S. and German firms whose defense-based divisions were selected for review and analysis.

Whereas most of the U.S. firms whose operations are discussed in Chapter Three are best characterized as "small businesses," the German samples are, to the contrary, drawn from medium to large-scale firms. Moreover, unlike their American counterparts, most of the German firms are only minimally dependent on defense production.

These differences were not anticipated when each of the sample selections were made. More cogently, these differences appear to be the result of the different acquisition strategies adopted by respective defense departments and the underlying industrial structure of each of the two countries.

Notwithstanding these differences, the data on the German firms presented in the following sections of this chapter are, we believe, sufficient for comparative purposes and provide the basis for initial conclusions on the robustness of the German defense industrial base.

Results from Field Research on Leopard-2 Manufacturers^{22,23}

This section provides empirical data and information on the manufacturers of the German main-battle tank, Leopard 2. The manufacturers

20 For a more complete discussion of this issue see Volume III of this report or Rand Report R-4141-ACQ cited earlier.

21 See footnote 20

consist of one prime contractor, six system manufacturers, and about 20 firms supplying important components and parts.²⁴

The original intention of the research staff was to compile most of the information by means of interviews with all these firms. However, even though the request for cooperation to the firms was accompanied by a cover note from the official *Bundeskademie für Wehrwaltung und Wehrtechnik*,²⁵ Mannheim, an affiliate of the German Ministry of Defense, the response turned out to be disappointing.

In particular, the prime contractor did not want to cooperate, afraid that information could leak out, endangering a possible order from Sweden. Another reason for the refusal to cooperate was that U.S. authorities financed the study. Given the negative experiences encountered by a number of German firms during the Leopard-2 design phase, German firms are not overly willing to provide information to a U.S. sponsored analysis. In addition, the prime contractor appears to have recommended to the systems manufacturers that they should not take part in the study for the same reasons. Moreover, the second-source prime-contractor did not cooperate because the firm is presently in a reconstruction and scale-down phase having received new changes in procurement planning from the German MoD, as well as, alterations to its existing projects. In such a situation the firm regarded the provision of information as competitively unwise.

Thus, the information provided here on the prime contractor and system manufacturers mainly stems from evaluations of annual reports, balance sheets, and a large amount of very detailed press material, as well as, from interviews with renowned independent tank and defense experts. Company interviews were made, however, with the majority of the suppliers of components and important parts. These were personal interviews of about two hours duration with two executives, generally including the director of the defense division and a production or sales executive.

Empirical Results

In the following report the manufacturers of the Leopard-2 are subdivided into two groups; the prime contractor and system manufacturers on the one hand, and the suppliers of components and important parts on the other hand.

The share of total sales contributed by defense activities is significantly higher for the first group (30-70% defense sales) than for the second group of firms (2-25%). The total annual sales attributable to the Leopard-2 program differ greatly between these groups. In absolute terms, they average 300,000 DM per tank for each of the first group and between 10,000 and 100,000 DM per tank for each of the second group, i.e., between about 4% and 10% of the price of a Leopard-2.

Prospects and problems of conversion differ as well. Apart from the quantitative aspect, conversion in the first group includes structural changes in the industry and organizational

22 The material that follows is abstracted from Volume III of this report and represents portion only of the total work completed by senior personnel of the Weltwirtschaftsinstitut Kiel in Germany.

23 The Kiel Report was translated into English by its authors. Although the translation is an accurate one, German syntax is sufficiently different than that of English to require the occasional restructuring of a sentence, or even of an entire paragraph. This editing was done by an American team but kept to a minimum in order to maintain the "spirit" of the interpretation of some data provided by the German team. An unedited and unabridged version of the Kiel Report is presented in Volume III.

24 The Kiel team used the word "sub-system" to describe what the American team would be termed "systems manufacturers" in the United States.

25 The Federal Academy for Defense Administration and Defense Technology. This organization is the equivalent of the United States Defense Systems Management College at Fort Belvoir, VA.

changes in the individual firms. In the second group, even though there are cases of severe changes, the firms are not affected in any significant structural way.

Prime Contractor and Systems Manufacturers

Company Performance

Krauss-Maffei, a corporation with 5,000 employees and annual sales of 1.4 billion DM, is the prime contractor for the Leopard-2 tank. The majority ownership position in Krauss-Maffei is held by one of the largest corporations in Germany (125,000 employees and 24 billion DM sales), minority ownership positions are held by the State of Bavaria and one of the Leopard-2's system manufacturers. The company has undergone substantial change over the past five years. In 1985, for example, the firm had annual sales of 2.0 billion DM and employed 5,200 persons. However, whereas 75% of sales were due to defense production, only 25% of the labor force worked in the defense division. This is explained by the very high share of inputs for tank production bought from other firms with Krauss-Maffei doing the assembly, and by the then poor performance of Krauss-Maffei's civilian divisions. It had been the policy of the German Ministry of Defense that in order to avoid a genuine highly specialized tank industry (or tank manufacturer), value-added with the prime contractor ought to be kept at as low levels as possible. Profits were very large in the defense area and in fact covered heavy losses in the civilian section, making overall operating results in 1985 and 1986 slightly positive with 0.1 million DM in profits earned in both years.

Between 1985 and 1990, defense sales dropped from 1,537 billion DM on average by 15% annually to 669 million DM, or a drop of 57% within five years. However, employment effects were by far not that large in the defense

section due to the low value-added nature of tank production. Because of this, employment decreased only slightly, from 1,250 to 1,100 employees, and to approximately 900 at the end of 1992. Total company sales declined by only 25% during this period inasmuch as civilian activities (plastics processing and general-processing technology) were increased. Dependency on defense declined from a 75% sales share in 1985 to only 46.4% in 1991. However, from 1987 to 1991, the share of exports in defense sales increased steadily from 23% to 40%. This will be discussed below as the "substitution-through-exports" effect below. However, the ratio of exports will certainly fall drastically in 1992 and after due to the new export regulations.²⁶

Today, the company claims to be pursuing a threefold strategy of conversion: cutting costs in the civilian section, enhancing civilian areas of business (in part with new products), and restructuring its organization, i.e., purchasing of companies in related civilian fields of business. The industrial experience gained by the firm in the defense area is expected to be only of a very limited use. Parts of the "know-how" acquired can be used for civilian application, e.g., in the area of simulation technology. The production sites, in particular for tank assembly, however, cannot be converted into civilian production, and only one product, transportable road beds, has a dual, i.e., civilian use, capability.

The Systems Manufacturers

Wegmann, the manufacturer of the turret for the Leopard-2, is pursuing a strategy of rapid diversification into civilian fields, at the same time using its defense know-how as effectively as possible. Wegmann's diversification program includes both the expansion of existing civilian product lines, in particular in the field of control and measurement devices, general systems electronics and automotive related products. In

26 See Volume III for a complete discussion of current (1992) German export policies.

keeping with this policy, it has purchased a number smaller firms in related areas.

As far as defense is concerned, the company is actively seeking to improve its market position and to actively respond to potential military requirements. Inasmuch as operating costs are becoming increasingly relevant in the military forces, experienced management "know-how" has become critical. Here, Wegmann is seeking to apply for new defense projects as prime contractor, and to thus use the administrative know-how acquired in managing a critical system for the Leopard-2. Since operation costs are crucial to the army, economizing on fuel requires expansion of simulation facilities, one of the technological strengths of the firm. Finally, since a smaller army implies also less personnel available for maintenance, the firm wants to largely take over maintenance services for the Bundeswehr.

As a result of this, the firm has managed to keep employment fairly constant at 1,800 employees over the last five years, while total sales decreased by about 5-10% per year from 780 million DM in 1987 to 610 million DM in 1990.

Two other system manufacturers, Rheinmetall and MaK, are following a different line of development. Rather than diversify out of the defense area, they have purchased stakes in other large defense-oriented corporations. One bought a majority stake in one of the most important other system manufacturers in the fall of 1990, claiming that defense technology "has been and will be" its core field of business. Since total procurement volumes are shrinking, the corporation seeks to exploit synergy effects, mainly in the area of armored vehicles, simulation technology and so-called autonomous or unmanned vehicles that have "dual-use" applications in defense and environmental protection. Hence, the share of defense sales could be kept constant at about 40%. For 1992, however, sharp cuts in the defense-oriented labor force,

approximately 1,000 out of 2,800 employees, are anticipated.

The Diehl Company, one other of the system manufacturers for the Leopard-2, not only bought a 25% stake of the second-source prime contractor but also purchased two large tank factories in Eastern Germany. By this it tried to meet a new demand in the defense area, which is destruction rather than the creation of equipment, in particular tanks and ammunition. Hence, the share of defense out of total sales (2.38 billion DM, 2.58 billion DM and 2.9 billion DM from 1988-90) remained constant at 45% in 1988 and 1989 and even increased to 48% in 1990. Employment increased from 14,000 to 15,000 employees from 1988-90 and will decline by only 600 in recession-year 1992. Since 1991, and especially in 1992, this firm has pursued a clear conversion strategy into civilian areas and will definitely strive to reduce its high dependency on defense sales.

Atlas Elektronik is a company with 3,300 employees, 1,690 of whom work in the defense area. The company has been pursuing an active strategy of enhancing civil areas of business since 1986. The main prerequisites for a successful conversion are seen in a well-specified and credible political planning of the future defense procurements. Given such a precise planning, combined with general political support for conversion, the company claims that conversion will take 4-6 years. In the absence of political planning, the company believes that full conversions will take 8-12 years.

Conversion is primarily performed by an enlargement of the already existing business fields of environmental protection, e.g., detection of sea and ground pollution with the help of radar and sonar technology and electronic guidance systems for traffic flows. The defense section is planned to focus on electronics for simulation technology and on applications for robots, or "auto-vehicles," as they are termed in German.

Short-run consequences of conversion comprise cutting costs for civil products through reduction of overhead and adapting the organizational structure of the firm.

Long-run consequences are a new direction of basic research as well as a change in the training of the labor force. Executives are calling for a public-task "environmental protection" program supported and financed by the Federal Government and claim that the restrictive changes in export legislation are a main obstacle for a successful conversion.

Conclusion

The important aspect of conversion with this group of firms is the change in the structure of the affected firm caused by the scale-down of the procurement budget. Clearly, all firms are reducing their defense activities in absolute as well as in relative terms. But under this rubric, two distinct strategies being pursued.

Some firms have practically "written off" all larger efforts in the defense area. The underlying belief is that there will be no more large procurement of armored vehicles or tanks and that the small projects fall below the minimum efficiency of scale. The market in Germany and Europe is not large enough for three main tank-building firms and hence these firms believe that it is better to withdraw from defense as far as possible and to minimize all capacities and efforts in this area.

There are other firms, in contrast, which are trying to focus on the new needs of the armed forces. The underlying belief here is that the army will undergo substantial qualitative changes, e.g., restructuring towards a rapid deployment force, that will make new equipment necessary. This will not consist of large main battle tanks, but of smaller armored vehicles that can be air-lifted. Furthermore, electronics is becoming more important and so is a standard

chassis for armored vehicles. Here, international cooperation is sought.

In addition, military operations will follow new directions. Reductions in manpower mean less combat personnel: e.g., smaller tank crews, making new technologies, such as autoloader, necessary; less maintenance personnel within the forces, hence more maintenance in industry facilities. Even if the cake is shrinking, these firms believe that it will not vanish.

These two strategies are matched on the level of the large corporations in Germany, some of which have been selling and others have been buying their shares in the group of prime contractors and systems manufacturers in the tank-building industry.

Suppliers of Components and Important Parts

The General Picture

This group of suppliers comprises firms located all over the Federal Republic of Germany, i.e., there is no regional concentration at all. Some of the firms are corporations (AGs), some are limited-liability companies (GmbHs). Most of them are affiliates of larger German corporations. Quite a number of firms began as family enterprises, and in fact in some of them families still own a substantial part of the shares. Ownership is entirely private in all cases and of German nationality in all but one case. The federal government has no shares in any of the companies, and none of them uses capital supplied by the government.

None of the firms is entirely or mainly producing in the defense sector, in fact the share of defense sales is below 25% for most of the companies. For some it is even a minor activity, accounting for less than 5% of total sales. Furthermore, the share of defense sales is negatively correlated with the size of the firm.

The production of Leopard-2 parts, however, was an important element in the overall defense activities of these firms. The Leopard-2 production accounted for one or two-thirds of the defense sales of many firms until about 1986, and for more than 20% of almost all firms. The relative importance of the Leopard-2 production, however, declined sharply in 1987 when procurement of this tank by the Bundeswehr and some NATO allies began to slow down. In the period from 1987-1990, the firms engaged in other defense activities, trying to keep the defense volume constant. From 1990 onwards, however, most firms reduced their defense sales and can be expected to do so in the future.

The components produced for the Leopard-2 were in almost all cases an in-house development, which generally required special know-how and technology. In addition, the production technology was developed by the companies themselves, with some receiving financial support from the procurement office. Whether or not firms received support, often depended upon the relevant firm's policy. Many of them did not apply for support in order to remain owner of the technologies.

As for the production of the Leopard-2 components there is no key input that is imported; foreign dependencies do not exist, except in two cases.

No exact data were provided on R&D expenditures, but firms claimed R&D expenditures to be substantially higher in the military sector than in the commercial sector.

Also, the ratio of engineers and technical personnel to total company personnel is clearly higher in the defense-oriented divisions than in their commercial counterparts, in many cases by a factor of two or three. Conversely, special training for the production personnel was required in only few cases. Reflecting the "hand-made" or customer-tailored characteristics of

Leopard-2 supplies, the percentage of less-qualified labor force in the production-line is lower than in the commercial branches of the firms.

None of the firms intends to increase the share of defense sales in total sales, and only few firms seek to keep it fairly constant. Most firms want to reduce defense shares substantially, but none of the firms wants to entirely withdraw from the defense sector within the next three or four years. The majority of the firms do not want to close their defense divisions but rather aim at a conversion to commercial applications, with the explicit option, however, of turning to defense again in case the already existing Bundeswehr procurement plans in the tank sector, e.g., armored infantry vehicles and armored artillery, are realized. For almost all the firms this implies a short-run conversion to their on-going commercial activities. Only two firms are clearly aiming at opening up new fields of business in the civilian area.

With one or two exceptions, none of the firms finds conversion an easy task. First, because the commercial sector is not booming, and second, because using a formerly military, and often more elaborate, production technology creates a cost-disadvantage in the civilian sector. Hence, many of them are still hoping for new tank procurements by the Bundeswehr.

As far as personnel is concerned, engineers and technical personnel now employed in the military area are often too highly specialized for the civilian sector and therefore only transferable at some cost. On the other hand, lay-offs are costly to the firms, too, due to the legally necessary social measures.

For the one or two firms which find that conversion poses no problems, two conditions are fulfilled. First, the military good is a spin-off of civilian technology and also produced on the

civilian production lines, and second, the defense share of total sales is less than 2%.

The Site Visits

Details of the site visits and interviews conducted at eight firms involved in the development and production of parts for the Leopard-2

program are presented below in order to provide a more detailed picture of some of the developments in the German defense industrial base, as these can be inferred from an analysis of the Leopard-2 program. For competitive reasons, the names of the individual companies will not be used in the report that follows.

Case I

General information. The company is a corporation, an affiliate of one of Germany's largest steel corporations. From 1986 to 1991 the number of employees world wide has been fairly constant at 6,000, while employment in Germany decreased from about 4,500 to 3,200 persons. Total corporate sales were 770 million DM in 1986 and steadily increased to 1.2 billion DM in 1991. In the same period the share of defense sales decreased from 18% to 12%. The fraction of personnel in the defense sector was 5% in 1986 and decreased to a mere 3% in 1991.

Importance of production for the Leopard-2 Between 1986 and 1991 sales of Leopard-2 parts (turret wire race bearing) fluctuated between 14% and 21% of total defense sales. The production technology is very defense-specific but not Leopard-2 specific. It stems from a development for the Leopard 1-and has since then been used for all defense supplies. Hence, there was neither Leopard-2 specific R&D, nor specific personnel training required.

Future development: prospects for conversion From the beginning of 1992, Leopard-2 orders have dropped to zero since there is no spare part or maintenance provision in the current program. The company is trying to keep overall defense sales constant at least in nominal terms. Conversion to civilian production is difficult, however, because the defense product and its technology has no civilian use. The production technology and sites could be used for commercial applications, but only at higher costs as they are more elaborate. Also, the "know-how" acquired in defense production has no civilian use. Since the company cannot easily shut down its production sites, it is pursuing a threefold strategy:

- 1- Furthering defense exports to NATO countries and to the Far East,
- 2- Opening up of an entirely new field of activity (space technology) and,
- 3- Conversion into its commercial activities despite the cost disadvantages, i.e., producing civil products on the military-production lines.

This last effort, however, requires substantial investment. Hence, given the technological constraints, the firm is seeking first to replace orders from the MoD by orders from other governments, secondly to replace defense orders with orders from the space sector called for by other Federal

Ministries, and thirdly to convert into civilian applications where the costs of this conversion are economically feasible.

Case 2

General information The company is a corporation in the automotive sector with 8,000 employees and 1991 sales of 1.41 billion DM (1986: 1.09 billion DM). Defense sales amounted to 11% of total sales in 1986 (122 million DM), decreased to 8% in 1987 and 1988, when Leopard-2 production slowed down, and increased again to almost 10% (135 million DM) in 1990 and 1991, when the company increased its export activities. The new German export legislation that gradually came into effect in 1992, however, puts severe constraints on defense related exports. As such, defense sales of the firm are expected to drop to 90 million DM in 1992 and 1993, and then decrease even further to 60 million DM, amounting to only 4.3% of expected total sales. The share of personnel in the defense sector is proportional to its share in company sales except that the number of executives per unit of output is relatively high with the number of engineers higher by a factor of three when compared to the civilian divisions of the firm. Conversely, the number of production-line personnel is lower.

Importance of production for the Leopard-2. The production of the Leopard-2 component "final drive and units for gearbox" accounted for one-third of all defense sales until 1986, dropped to 15% in 1987 from where it declined to 5% in 1991. In 1992 and 1993 some spare parts of negligible dollar value will be manufactured. The technology had been produced in-house with financial support from the Federal procurement office. R&D expenditures are claimed to be twice as high in the defense sector as compared to the commercial sector.

Future development: prospects for conversion. Currently, the defense division is engaged in export activities in many Western countries, but facing severe legal constraints. Therefore, it is trying to convert its capacities into civilian use. However, of the production sites for defense goods only 70-80% can be converted and would imply cost disadvantages. Additionally, the commercial sector is not expanding sufficiently at the present time to be able to absorb the production capacities of the defense division. It is estimated that only 20% of the personnel reduced in the defense sector can remain in the company, the other 80% have to be reduced through lay-offs, which are, given German social legislation, costly to the firm.

The real problems are not of the quantitative but rather of the qualitative kind. The engineers and technical personnel working in the defense sector, are the most qualified in the firm and are a general source of know-how to the whole company. This part of the work force, however, cannot be easily employed in the commercial division. In trying to convert the company has contacted all relevant authorities in the FRG for issues of conversion and of export legislation.

Case 3

General information. The company is one of a number of German-based subsidiaries of a large U.S. corporation with annual sales in excess of \$6.0 billion U.S. The parent company has, itself, sharply

cut its defense activities from about 15% of its total sales volume in 1988 to about 5% in 1991. The German subsidiary that has contributed to the Leopard-2 program consists of a defense and a commercial division of approximately 500 to 600 employees each. Total sales in the defense division amounted to 200 million DM in 1987 and have decreased annually by 10 million DM to 150 million DM in 1992. The defense sales are estimated to drastically drop by 25% per year to below 90 million DM by 1994.

Importance of production for the Leopard-2. The production of the Leopard-2 components "gyroscopic stabilizer" and related equipment provided annual sales of about 15 million DM in 1987, which is between 7% and 8% of total defense sales. From 1987 to 1991 these sales declined proportionally to the decrease in all defense sales. From 1992 onwards, however, they will drop to almost zero. All the know-how, intellectual property as well as the production technology came from the U.S. parent who developed the product. Hence, as a result of this, there was no R&D effort linked to the German production of Leopard-2 components.

Future development: prospects for conversion. The German subsidiary has undertaken substantial R&D efforts in its overall defense division (roughly 30 million DM over the five years until 1990, compared to only 1 million DM in its commercial division) in order to stay in business. It provides several components and electronic parts for many tanks and other defense products. In particular, this firm would be involved in one of the two large armored vehicle programs now part of the official German defense plan. However, this program was reduced in projected volume at the beginning of 1992, and it is doubtful whether it will be funded. Given this situation in particular and the declining volume of defense sales in general, the company will have to reduce its labor force by 100 people per year (i.e., 20-25%) for at least two or three years. At the same time, it wants to convert its capacities to civilian applications.

This is considered to be impossible for roughly half of its defense plants because technologies and products are exclusively defense-specific. For the other half it would be possible without much investment in physical or human capital. The major constraint to conversion facing the defense divisions is the small size of the market for the firm's products.

Case 4

General information. With 1000 employees, this corporation is a subsidiary of a large German corporation. Total sales for the firm are presently 200 million DM per year. As of 1991, defense sales were 54 million DM. These sales were generated by an 110 person workforce.

Importance of production for the Leopard 2. The production of the Leopard-2 components "ballistic protection" and related equipment provided for annual sales of 30-35 million DM between 1986 and 1991, accounting for more than 50% of the defense sales, and for 15% of total sales of the company. The product for Leopard-2 was designed in-house in cooperation with the relevant systems manufacturers. During the main phase of Leopard-2 production (1975 to 1985), about 20 patents were granted, from 1986 on three patents were granted. No patents were generated by civilian R&D.

Between 1986 and 1991, investment in machinery and equipment for Leopard-2 production totalled 4 million DM. In addition, the Federal government provided the special means necessary for assembly. Title to this property will remain with the government.

Future development: prospects for conversion. Sales accruing from deliveries to the Leopard-2 program have dropped by 90% in 1992 to only 3 million DM for spare parts. From 1993 onwards they are expected to halve again. The other defense sales are dependent on additional government procurement still being debated by the German MoD, such as the upgrading of the Leopard-2. Since these programs have been postponed, and might eventually be canceled, the company has had to revise its sales estimates downwards by some 20 million DM. The defense sales, and Leopard-2 in particular, did provide high contribution margins. For example, the 20 million DM downward correction in defense sales include 5 million DM in contributions to corporate overhead. In consequence of this loss, the company fears its overall operating results will become negative. As a first-round effect, almost half of the work force in the defense production will have to be laid off, but there are also negative employment effects on the company as a whole.

For the other half of the defense work force, the company is trying to develop commercial substitutes, mainly in the automotive industry (heavy industry vehicles in particular). The production sites can be fully utilized, with the production technology used in part for other applications. The product itself, however, has no civilian application.

Case 5

General information. The firm, now one of Germany's largest privately owned (GmbH) corporations, began as a small family enterprise at the beginning of the century. With 1991 sales in excess of 1.6 billion DM, it is now one of Germany's largest suppliers of automotive components and parts. Until the mid-1980s, defense sales accounted for only 3% of total sales volume, and have since decreased to less than two percent.

The company was restructured in 1990, and all non-automotive-related activities, among them defense, were grouped in a subsidiary. This subsidiary has 1,000 employees, annual sales of 150 million DM, of which approximately 30 million DM are defense related.

Importance of production for the Leopard-2. Production of various forms of cooling devices, i.e., radiators for the Leopard-2 program accounted for more than half of all defense sales; 18.6 million DM per year until the mid-1980s. The products for Leopard-2 themselves, as well as the production technology, were developed in-house. At the beginning of the 1980s, an entire production facility was constructed for Leopard-2 components. Investments totalled 20 million DM with machinery and other production equipment using 14 of the 20 million DM expended for the facility. Between 1986 and 1987 sales accruing from the Leopard-2 business dropped by 50% to 9.4 million DM and again to 6.5 million DM in 1990 and 1991. From 1992 onwards they will be zero.

Future development: prospects for conversion. When all of the special activities of the company were grouped together in a subsidiary in 1989/90, it was planned that the 20% defense share should increase or at least be stabilized. However, two years later the share had declined to 16% with the future trend pointing downwards. The defense products, in particular tank-relevant products, have no civilian use. Due to defense-specific requirements, the production facility cannot easily be converted to civilian production. The company estimates that the capital costs of between 2 to 5 million DM will be incurred if the facility is to be converted to commercial use.

Of the general know-how acquired through Leopard-2 production only very fundamental techniques have a positive spin-off for civilian production. Hence, since capacities still exist, the abrupt collapse of Leopard-2 follow-on production as well as of exports cause three problems in the medium-run; First, defense products are developed, produced and tested "by hand" so that sites and personnel cannot be easily converted to civilian mass production. Second, defense contributed substantially to profits (with the official rate of six or seven percent and profit rates in exports being even higher). Third, a non-negligible share of general R&D, in particular basic research, could be booked on defense contracts. Therefore, the company is hoping for follow-up tank programs. If these do not materialize, there are plans to close down the defense capacities entirely.

Case 6

General information. The company is a subsidiary of one of the largest steel corporations in Germany and produces components almost exclusively for the automobile industry. However, defense-oriented sales, mainly inputs for armored vehicle and tank programs, have accounted traditionally for approximately 10% of the firm's sales volume.

Total sales increased from 88 million DM in 1986 to a peak of 108 million DM in 1989, and have since fallen 90 million DM in 1990. Until 1995, a slight increase to 94 million DM is projected. Defense sales were almost ten per cent in 1986, abruptly declined to just above 5% in 1987. From 1992 they are expected to decrease, to 2.5% of total company sales in 1995.

Importance of production for the Leopard-2. Sales of the "suspension" components for the Leopard-2 accounted for almost 65 percent of all defense sales; 5.5 million DM in 1986. Since then, Leopard-2 sales have fluctuated between 3 million DM and 4 million DM per year with a drop in sales in 1992 to 1.5 million DM. From 1992 on, sales, primarily for spare parts, are estimated to be in the 500,000 DM per range.

Future development: prospects for conversion. The company does not foresee any substantial problems deriving from the scale-down of tank procurements. The Leopard-2 component was developed in-house, together with the prime contractor and the procurement office. However, while R&D in the commercial sector is 5-6% of total sales, it is only 1% in the defense sector, with no patented spin-offs here. The Leopard-2 component is produced on civilian production lines with technology used for both military and civilian products. Only one processing plant for special steel was installed at 2.5 million DM in 1984. Hence, conversion poses no problems, and all of the labor force engaged in the defense sector can be absorbed in the civilian lines of production.

Case 7

General information. The company, the majority of whose shares is still held by the founding family, has the business status of a K-corporation.²⁷ For 1992, total sales are estimated to be slightly less than 4.0 billion DM world-wide. The company currently has 37,000 employees.

The unit discussed here is an integrated division of this corporation, with annual sales of 260 million DM and 2,200 employees. The ratio of defense sales has remained fairly constant at 4% over the past five years, and is estimated to decline to 3% by 1994.

Importance of production for the Leopard-2. The shares of sales of the Leopard-2 components "ball bearings" in all defense sales fluctuated between 33% (1986) and 16% (1991). It will decline to 5% of sales, and then 3% of sales in 1992 and 1994 respectively.

The component was developed in-house, but no patents were applied for. The number of personnel entirely working in the defense sector is very small; a total of 35 persons, six of whom are engineers. Sales productivity in the defense area is approximately 300,000 DM per employee. While overall profits of the division have fluctuated between 10% and 0% from 1986 to 1991, profits in the defense area have remained constant at five percent.

Future development: prospects for conversion. The product and the technology have no civilian application. Since the relative importance of defense sales in general and Leopard-2 components sales in particular is low, there is no actual problem of conversion.

Case 8

General information. The corporation has almost 6,000 employees, and 1991 sales amounted to 840 million DM, most of which is in the medical technology area, with some sales generated by applicable safety and space technologies. The share of defense is small, and the goods supplied to the armed forces are reverse spin-offs (i.e., of commercial developments).

Importance for the production of Leopard-2. The share of the Leopard-2 sales has never been greater than 0.5% of total company sales. The Leopard-2 product, though of relatively low cost, is a high-technology product with the firm having a world-wide reputation in this area. Accounting with respect to Leopard-2 business followed the usual routine: the costs claimed by the firm were reimbursed with a 7% markup. Auditors regularly checked on the costs. In the main period of procurement the firm employed three or four engineers for R&D as well as for quality control procedures for the component supplied. It installed 2.0 million DM of special production machinery for the Leopard-2 program as well as one workshop.

Since 1988 sales from Leopard-2 components declined, becoming zero in 1992.

²⁷ A "K" corporation is unique to Germany in that it is a hybrid which combines the features of a stock corporation with those of a limited partnership. This is of no significance to the discussion at hand.

Future development: prospects for conversion. The product and the technology came from the civilian sector; the reverse spin-off has some defense-specific features, though. All factors of production can basically be converted to civilian use.

Consequences of the Scale-Down of the Defense-Acquisition Budget

When the post-World War II decision was made to reconstitute elements of the German defense industrial base, responsible government officials and, in particular, executives of the Federal Procurement Office found it difficult to get the cooperation and the interest of private-sector firms. Gaining this cooperation was particularly difficult as far as tanks were concerned. Reimbursement of costs plus a guaranteed markup for profits was then one of the major means to overcome the objections of the private sector. As time went on, during the Leopard-1 and even more so during the Leopard-2 production, firms realized that this was not only a source of seemingly stable revenues and incomes, but that production of the tank also enhanced the firm's international reputation. Around 1988/89, when the end of large-scale Leopard-2 procurements by NATO forces was foreseen, the reaction of Krauss-Maffei as well as a number of system manufacturers was not to step out of the defense business but to apply for funds for upgrading programs as well as other tank-procurement programs. However, the end

of the Cold War put an end to many of those endeavors and slowed down others. As a consequence, some of the firms increased their exports to NATO allies and other Western countries. This did not necessarily lead to an increase in defense sales, but rather was a substitute for the drop in domestic demand in order to sustain the capacities installed. This action, however, has more and more been blocked by the new export legislation which gradually came into effect in 1991 and 1992.

The double effect of the discontinuation of the Leopard-2 program and its not being replaced by other government procurements plus the new restrictive export rules on the other hand put an end to clearly definable defense activities. This development, which was characteristic, if not identical, for all of the firms, is depicted in Figure 3.

The small share of defense sales out of total sales was politically desired. Within the defense area, Leopard-2 provided the largest share because it initiated the firms' activities in the

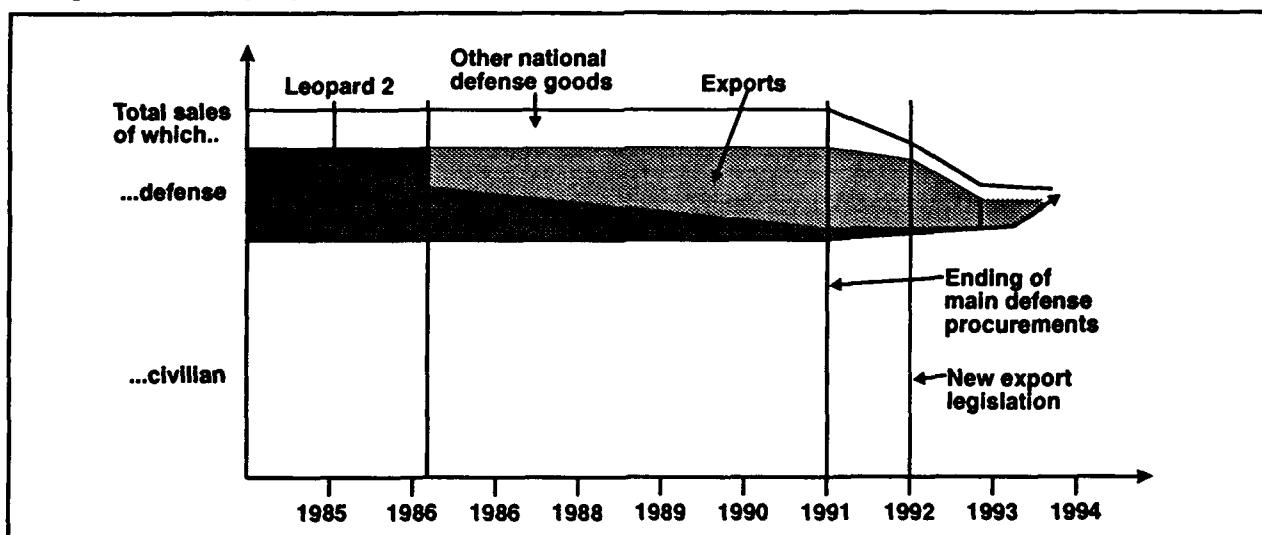


Figure 1. A Simplified Illustration of the Trends of Defense Sales, Leopard-2 and Exports

defense area. When the demand for Leopard-2 components first declined around 1986/87 they were substituted by other defense activities, often exports. This can be regarded as the first conversion period for the firms involved in the Leopard-2 program. In 1989/90, the Leopard-2 program began to expire for many suppliers of components. The gap was again filled by an increase in export activities. In 1991, not only did the Leopard-2 program expire fully, but also the exports were cut by export regulations. As a consequence of this, the firms involved in the production of the main battle tank have sought to reduce their defense activities as well as their capacities in this field.

Thus, conversion has two aspects; one technological and one managerial. The technological (or "internal") aspect of conversion is defined by physical constraints given to a firm by its choice of technology and by its current investment in plant and equipment. It cannot be altered instantaneously or without cost and

therefore puts a limit on the reaction possibilities of a firm, at least in the short run.

The managerial (or "external") aspect refers to the markets open to a firm and thus co-determines the actual outcome of conversion. The following two sections present a picture of the empirical results among the firms involved in the Leopard-2 business on these two issues of conversion.

Technological Possibilities of Conversion

A substantial portion of the interviews conducted with the firms focused on conversion issue. The technological and physical aspects were subdivided into five categories: personnel, capital stock/production sites, production technology, general know-how/technology of the product and, finally, the product itself. Arranged in this order the degree of technical convertibility is illustrated in Figure 4.

With one exception, none of the firms produces a "dual-use" product for the Leopard-2. For

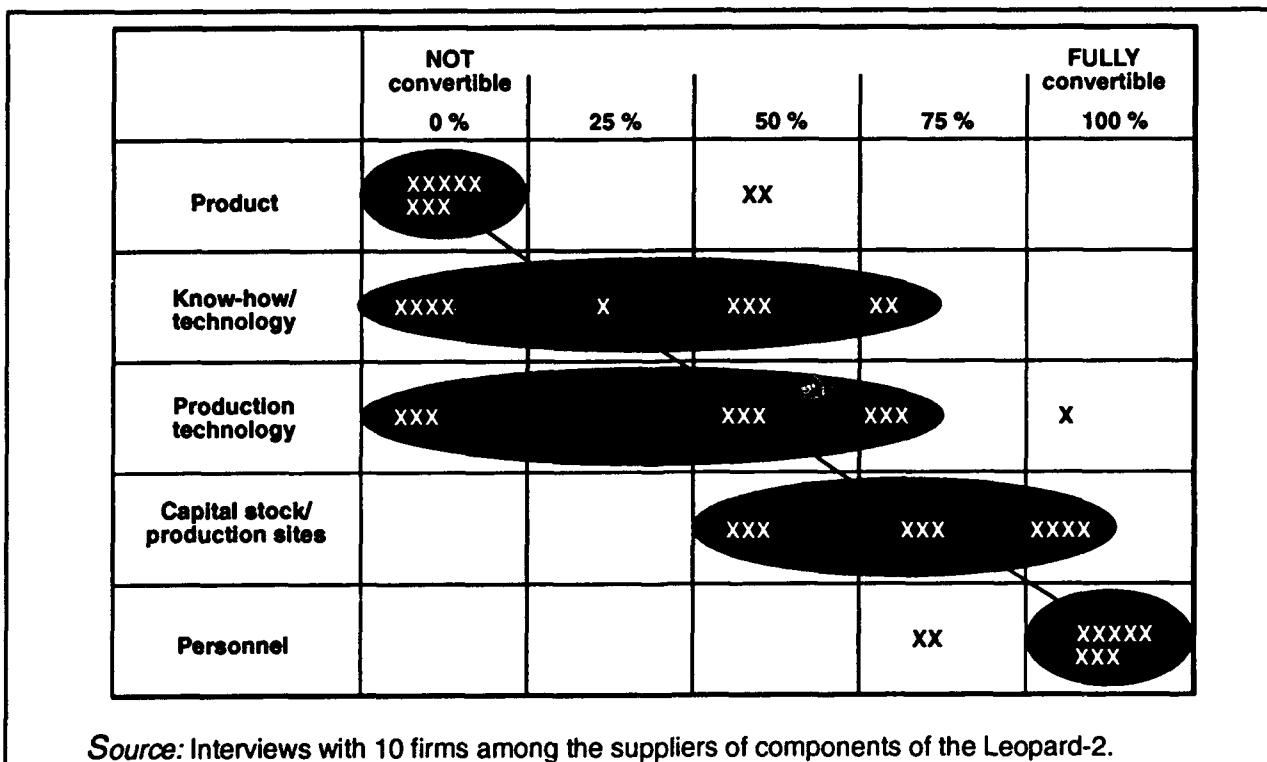


Figure 4. Extent to which the firms can use items of military production for civilian application

about half of the firms the basic know-how of military production has no civilian use. For many firms the production of Leopard-2 components demanded a special production technology (including special raw materials, special quality-testing procedures), which in some three cases is not convertible at all. Conversely, in six of the cases partial conversion is possible.

The capital stock can in general be used for civilian production; two of the three companies claiming a 50% convertibility foresee substantial cost disadvantages when using the military sites for civilian production.

As far as the personnel is concerned there are almost no constraints to a transfer of these personnel to commercial use.

Actual Conversion

This section presents a summary of the firms' plans for conversion, and their reaction to the scale-down of defense budgets. In Figure 5, the

right-hand side represents the difficult aspects of conversion.

It can be seen that most of the firms produced the components of Leopard-2 on highly specialized production lines; in only two cases was the military good manufactured in a commercial facility (first row). Military capacities are not fully used at the moment, and personnel has to fear lay-offs to a large extent (rows two and three). However, conversion is planned, mainly into existing field of business, usually into a field that is close to the core competence of the firm. Only one firm is seeking to enter a new field of business with its former defense capacities. Quite obviously, the survey has taken place in a key phase of change in the firms, i.e., in the summer and fall 1992. When the interviews were conducted, the final part of the new export legislation had just come into effect. Hence, the blocking of one kind of product substitution (exports) is quite new with its final effect on the German defense industry not yet known.

	100:0	75:25	50:50	25:75	0:100	
Defense production on civilian production lines	XX	X			XXXXX XX	Defense production on pure defense production lines
Capacities for defense production fully used now	XX		XX	XXXX	XX	Capacities for defense production fully unused now
Personnel fully taken over by civilian section	XX		XXXX	XXXX		Personnel of defense section fully laid off or to be laid off
Conversion into existing area of business	XXXXX X	XXX			X	Conversion into new area of business
Conversion entirely concluded	XXX		XXXX	XXX		Conversion not yet begun
Obstacles to conversion mainly posed by lack of demand in civilian market	X		XXXXX XXX	X		Obstacles to conversion mainly posed by technological constraints

Source: Interviews with 10 firms among the suppliers of components of the Leopard-2.

Figure 5. Interviews with 10 firms among the suppliers of components to the Leopard-2

Therefore, in spite of the fact that all of the firms are fully aware that defense capacities can no longer be sustained and that conversion programs have to be enacted, full conversion has been performed only by a minority of three firms (row five). For the greater number of the firms conversion is still in the process of realization and not yet concluded. In addition, most firms find conversion difficult because of constraints imposed by markets not expanding sufficiently fast in order to fully absorb formerly military capacities.

Conclusion: Has Conversion Been Successful?

Conversion is definitely taking place in all firms. Firms have been implementing strategies for strengthening their non-military sales since 1989, with many of them, however, maintaining some defense capacities. From 1991/92 onwards the efforts towards closure of the defense area have been accelerated with specific planning for the future of the defense division halted.

In contrast to the group of system manufacturers of the Leopard-2 this does not imply structural changes within the firms, nor a new orientation of the firms' activities.

Two firms interviewed have successfully converted; they had it easy because they are the firms that had produced the military good on civil production lines, with know-how, physical and human capital stemming from civilian production. For these two firms the defense activity had clearly been a side activity.

Then there is a large group of firms with partial success. Conversion is generally possible and has begun, but cuts in sales, R&D and employment in the defense division are necessary. The factors of production cannot easily be absorbed or taken over by other civilian divisions. Furthermore, there are technological constraints as well as constraints given by the market that

impede an easy conversion of activities. Cuts in employment in the defense section vary between 30% and 100%, which is about five to ten percent of overall employment, depending on the relative size of the defense section. However, as mentioned above, it is rather the qualitative than the quantitative aspect of cuts in employment, sales and R&D that creates the adjustment problems.

The third group consists of two firms that face a clear deterioration of overall operating results through the cut in defense. In particular, orientation towards the civil market is difficult because the firms are trying to move into the market for components for the automotive industry, where they currently lack experience and a product reputation.

Concluding Remarks

The German system of industrial organization, when compared to its U.S. counterpart, exhibits some features which tend to increase and some which tend to decrease the international competitiveness of the economy as well as the scope for adjustment to changes in the demand for military goods. For example, the mere fact that U.S. venture-capital markets are reported by many authors to be far more efficient than the German ones, only points to a partial aspect of the adjustment potential. It may well be that other external aspects such as the educational system or the capital market compensate for this and make the German system more flexible than the U.S. system.

In other words, whereas some of the marginal productivities may now and then indicate otherwise, the total productivity of the German system may be fairly high.

Executive Summary

The intent of the study was to provide evidence on the adjustment process in the wake of a declining defense-acquisition budget in Germany. It turned out that important parameters

of adjustment vary with firm size. The large corporation typically has a small defense share and correspondingly an insignificant impact on the firms' strategies. Similar reasoning applies to the small corporation which normally is a sub-contractor to the larger firms and has specialized in components and parts. It is only the medium-size corporation which is strongly affected.

In comparison to the United States the scope of the future adjustment problem in Germany will be small, the reason being that the defense related sales of German contractors have been much smaller than their U.S. counterparts. In fact, there is no large corporation with a defense share nearly as high as those of the leading U.S. prime contractors. Moreover, in the case of the Leopard-2, the firms involved in this program began the conversion process after 1987, with this process now being close to completion. Conversely, current German legislation on exports has had a negative effect on the German defense industry and its related "dual-use" businesses.

With respect to industrial organization issues the following picture emerged: The German defense-procurement market has been far more cartelized than the U.S. market. This could have been expected due to the relatively small market size in Germany and the "buy national" practices of industrial countries.

From a broader perspective important markets, such as the labor and the capital market, differ in their institutional setting, with the German labor market being sector-oriented and heavily cartelized. In Germany it is the trade unions and employers' organizations, instead of the parliament or the government, who effectively fix minimum wages. With respect to capital markets the big banks are a major part of the informal cartelization network. Whether this form of corporate structures alleviates adjustment problems in the defense business or whether a more arms-length relationship would be superior remains open.²⁸ A full discussion of the issues touched on in this paragraph is set out in Volume II of this report. Because of the inherent complexity of these matters, they cannot be treated adequately in a footnote.

28 A full discussion of the issues touched on in this paragraph is set out in Volume II of this report. Because of the inherent complexity of these matters, they cannot be treated adequately in a footnote.

Summary Overview: Firm specific consequences of the scale-down in the defense budget
-The Case of German Arms Producers as of Fall 1992-

Type of Company	Employment per company (average)	Average defense share in sales (%)	Scale-down impact on			
			Firm Structure	Employment	Firm Strategy	Economic results
The large corporation* <i>Conversion Strategy:</i>	213,000 <i>Purely external:</i> • Sale or purchase of firms	4	no	no	no	no
The medium-size corporation** <i>Conversion Strategy:</i>	19,00	47	yes	yes	yes	yes
The small corporation*** <i>Conversion Strategy</i>	4,200	11	no	minor	minor	minor
<p><i>Internal:</i></p> <ul style="list-style-type: none"> • Increase of defense share • Search for new fields of production <p><i>External:</i></p> <ul style="list-style-type: none"> • International cooperation 						
<p><i>Internal:</i></p> <ul style="list-style-type: none"> • Capacity decline in defense production • Capacity increase in civilian fields of production <p><i>External:</i></p> <ul style="list-style-type: none"> • Arms exports 						
<p>* Daimler-Benz; Siemens; Thyssen; Mannesmann.</p> <p>** Rheinmetall; Krauss-Maffei; Wegmann; MaK; Blohm & Voss; DASA.</p> <p>*** Hoesch Rothe Erde; Clouth; Zahnradfabrik Friedrichshafen; Behr; Dräger.</p>						
<p>Source: Own compilations.</p>						

Chapter 6

CONCLUSIONS ON THE ROBUSTNESS OF THE GERMAN DEFENSE INDUSTRIAL BASE

Based solely on an analysis of the data presented in Chapter Five, we do not now believe that any final conclusions can be drawn about the relative robustness of the German vs. the U.S. defense industrial base. In our opinion, for this to be done, additional data is needed.

Nonetheless, our review of the material presented in Chapter Five suggests strongly that the German defense industrial base is more robust than that of the United States and that it will be better able to reconstitute itself in the future should this be required by an emergent military threat. The reasons underlying this seemingly contradictory conclusion are based upon the more complete investigation of the German economic system that forms the basis for Volume II of this report, to wit:

German industry began restructuring itself after 1987 in anticipation of stringent reductions in both German and European defense budgets. This restructuring process is virtually complete now, suggesting that the German defense industrial base is reasonably well-sized to whatever the future demand for its output may be. Notwithstanding this, the restructuring process undertaken by private industry has taken on two different strategic thrusts.

First, many of the firms involved in defense production simply down-sized, gradually reducing the resources committed to defense production while beginning to expand their commercial operations in both traditional and

new markets. To date, this effort appears to have been reasonably successful.

Second, other firms expanded their defense-based operation by acquiring a number of smaller firms as the basis for giving them a more comprehensive capability in what they openly recognized was to be a smaller, but more competitive market. A central feature of this process was the creation of a number of pan-European joint ventures whose ultimate effect will be to limit, at least in Europe, the type of destructive cross-border competition that might otherwise obtain in a down-sizing market. Critically, one of the strategic imperatives here has been the formation of industrial groups with the systems integration capability that is the hallmark of the American defense industry. As such, it is reasonable to assume that various partners to these pan-European joint ventures are positioning themselves to compete more effectively with American and, prospectively, Japanese industry, and on a world-wide basis.

Moreover, given the acquisition policies of the German Ministry of Defense, it appears safe to assume that most of the German firms will maintain the intellectual know-how to reinstitute defense production should it be required. The conclusion here is based on the fact that the research and development process is more widely diffused in Germany than in the United States, that is to say, that programmatic responsibility for research and development is not centered mainly in the prime contractor but dif-

Conclusions on the Robustness of the German Defense Industrial Base

fused through the lower tiers of the defense industrial base. This allows the lower tier firm to protect this capability for any future business potential.

Although not evident in the data presented in Chapter Five, German industry, and in particular the medium-sized firm that forms a significant portion of the German industrial base, is more capital intensive than their U.S. counterparts. This factor, coupled with the extremely high-quality labor force that is the hallmark of German industry, allows German industry to produce efficiently at relatively low levels of output. More critically, the two factors taken together along with the intellectual property ownership rights alluded to earlier should enable the German firm to reconstitute production more rapidly and efficiently than a similar-sized and placed American firm. Significantly, German economic policy reinforces this potential by creating an environment in which a heavy emphasis is placed on maintaining labor force stability. Reductions in the size of a firm's labor

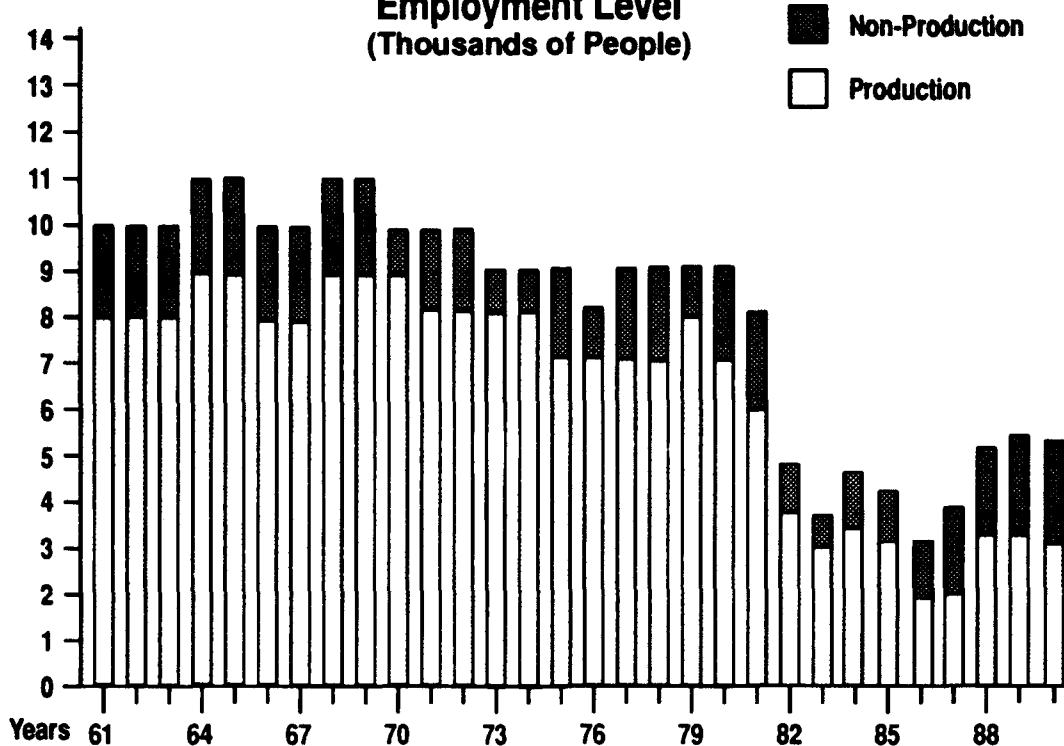
force are legally difficult and expensive. Because of this, the more normal practice for a firm facing a reduction in the size of its labor force is to try to develop new products and/or markets to which an otherwise redundant labor force can be transferred. As has been suggested, former East Germany and, indeed, the former Soviet bloc countries are seen as potentially significant markets for West German industry and may provide a more than adequate offset to lost defense sales.

A more complete analysis and discussion of a number of these issues are set out in Volume II of this report. This volume looks at a number of the key institutional forces in the German economy with particular emphasis placed on the interaction of these forces as they influence German corporate organization and managerial behavior. As stated many times before, Germany differs greatly from the United States politically, culturally, and economically. These critical differences are the central focus of Volume II of this report.

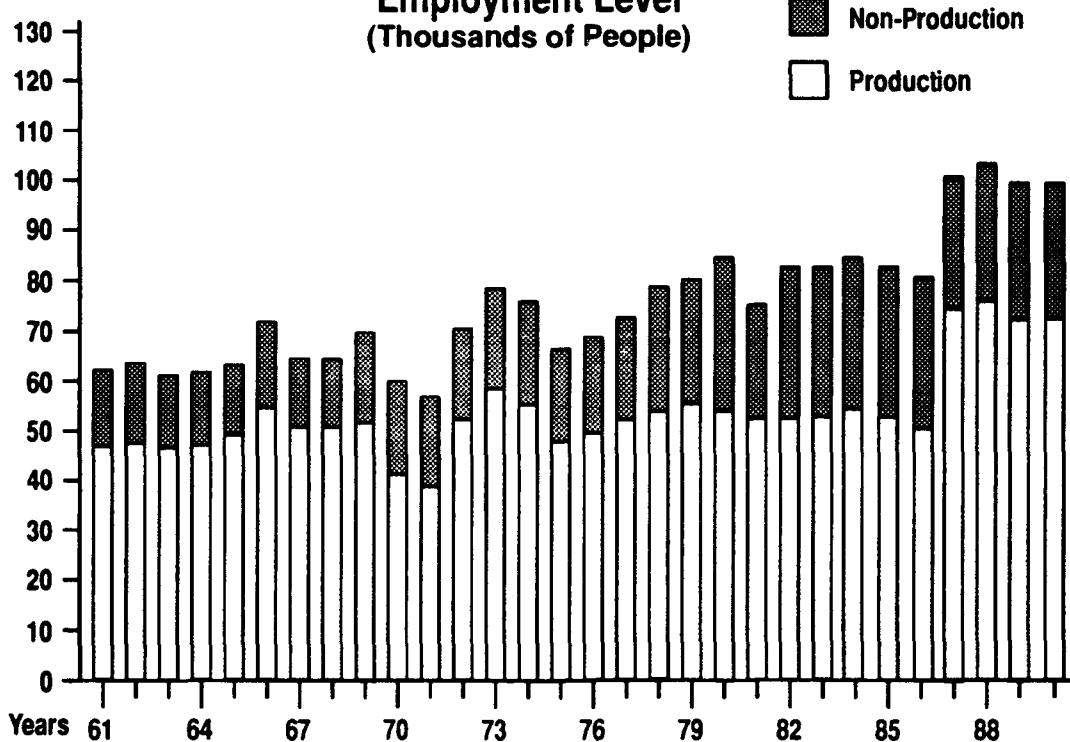
Appendix:
INDUSTRY EMPLOYMENT DATA:
1961-1991²⁹

²⁹ Source : The U. S. Department of Labor and the U.S. Department of Commerce.

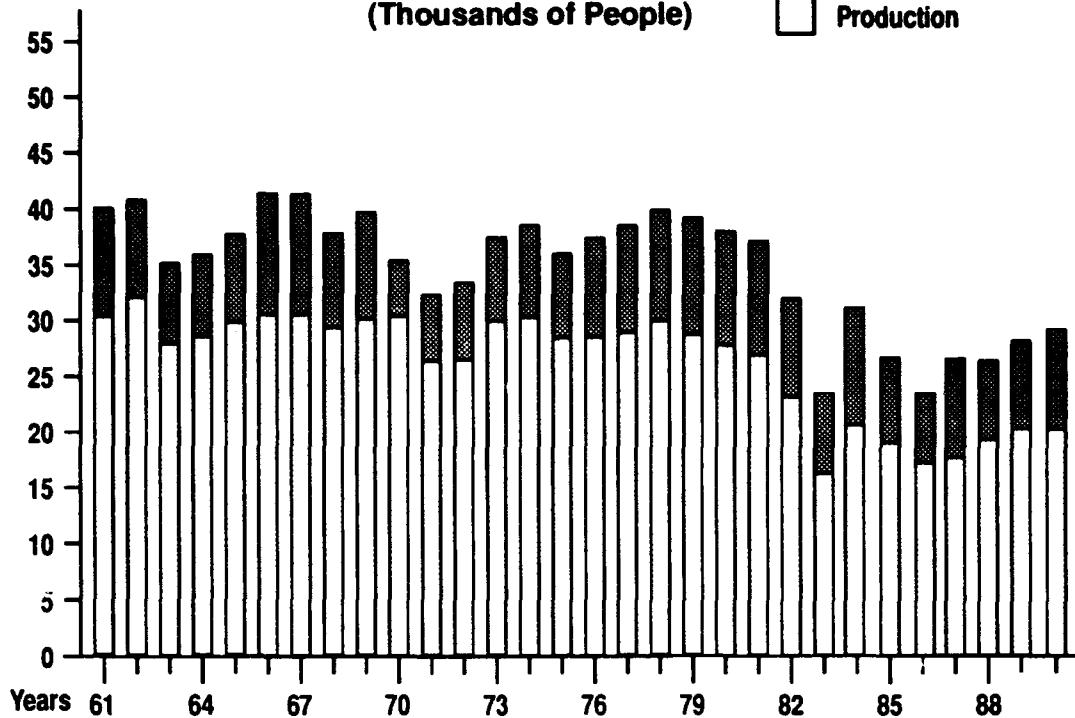
3313 Electrometallurgical Products
Employment Level
(Thousands of People)



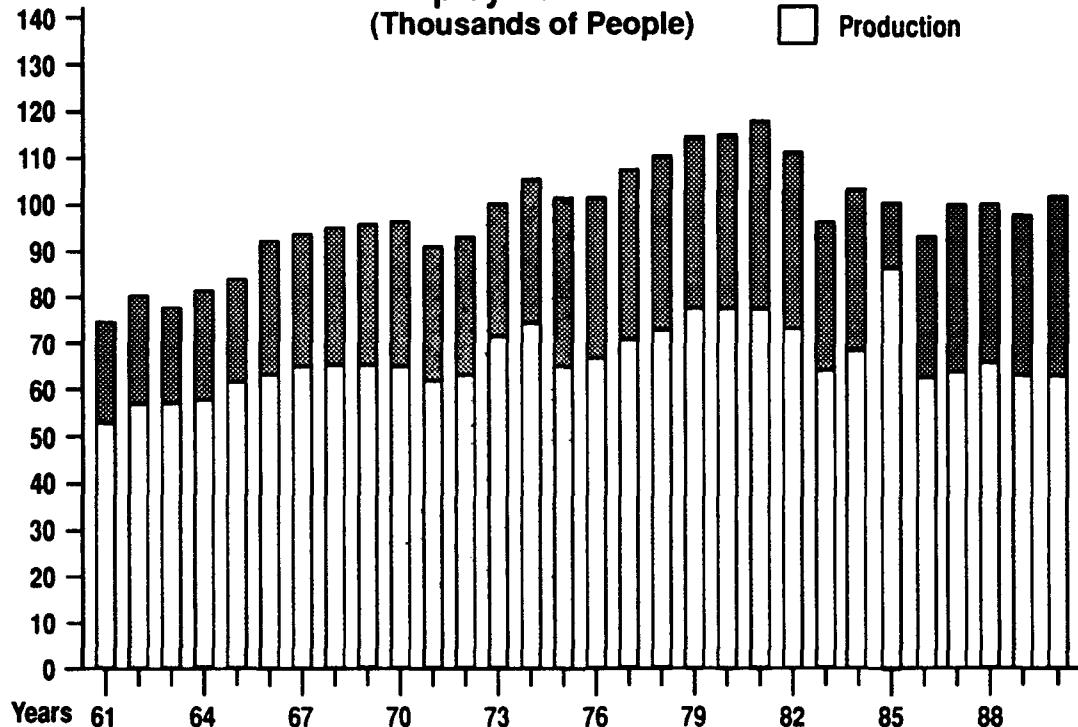
3444 Sheet Metalwork
Employment Level
(Thousands of People)



3462 Iron and Steel Forgings
Employment Level
(Thousands of People)



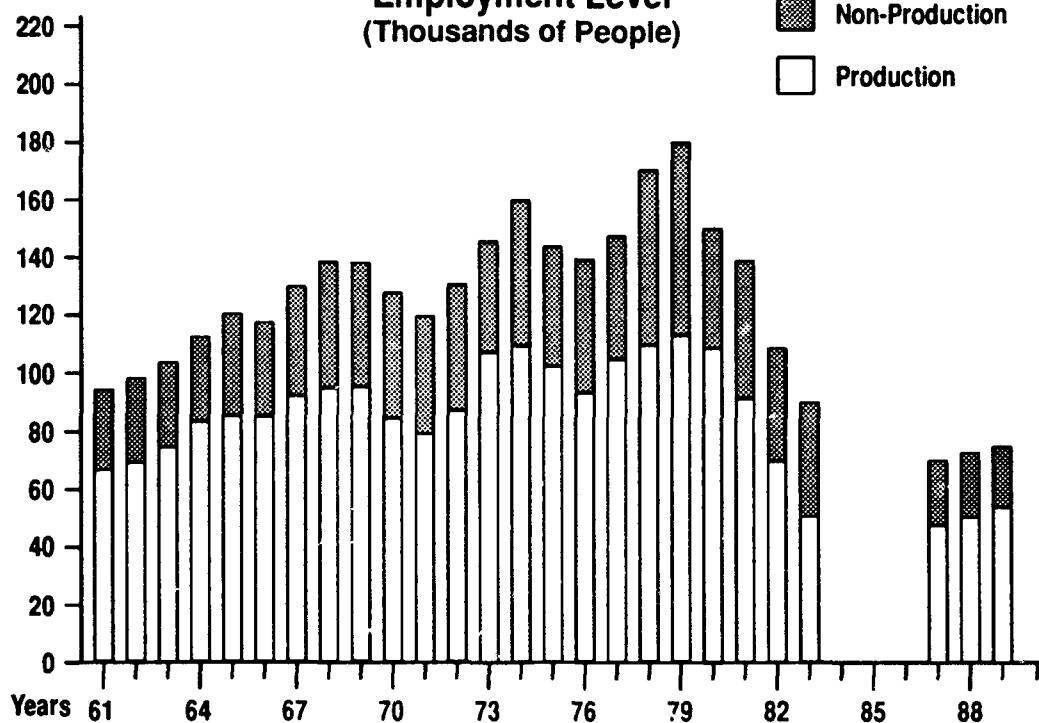
3494 Valves and Pipe Fittings
Employment Level
(Thousands of People)

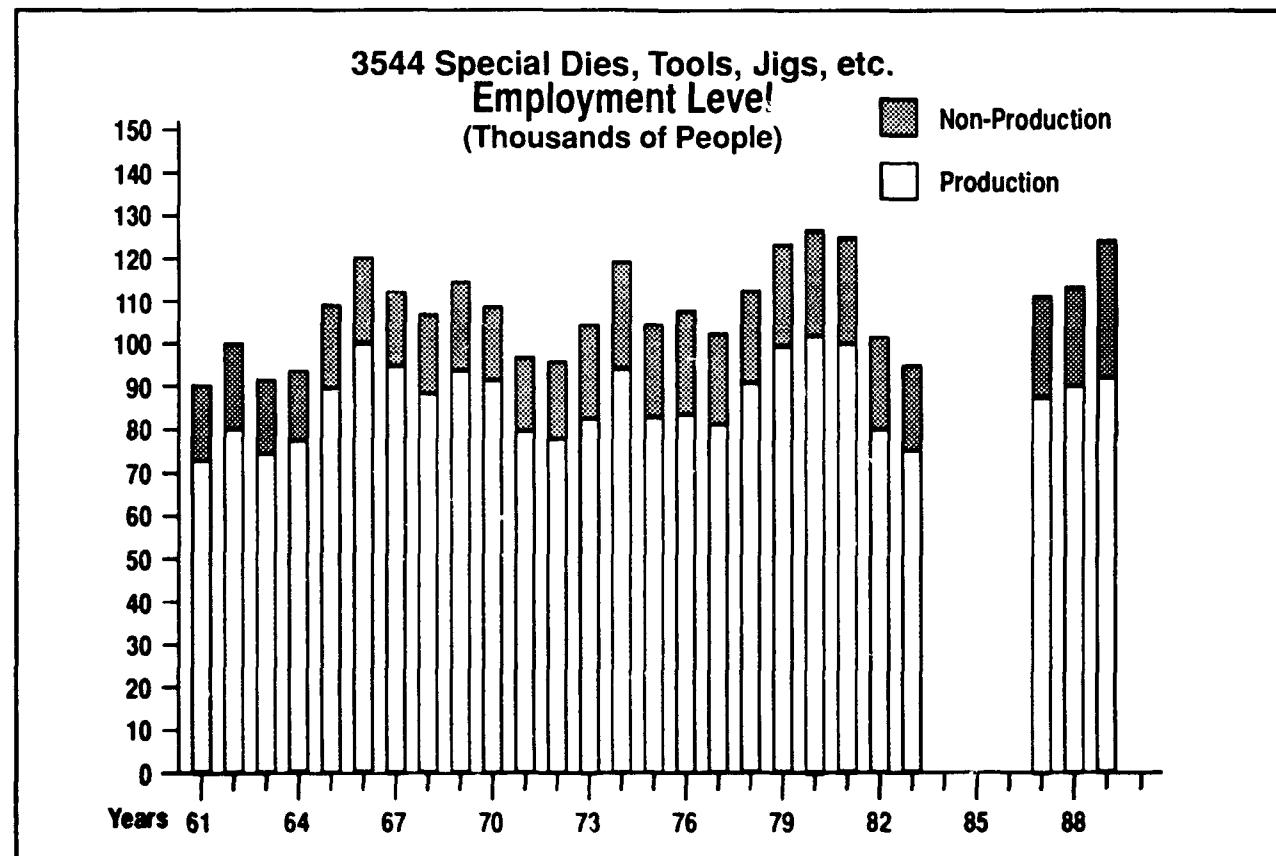
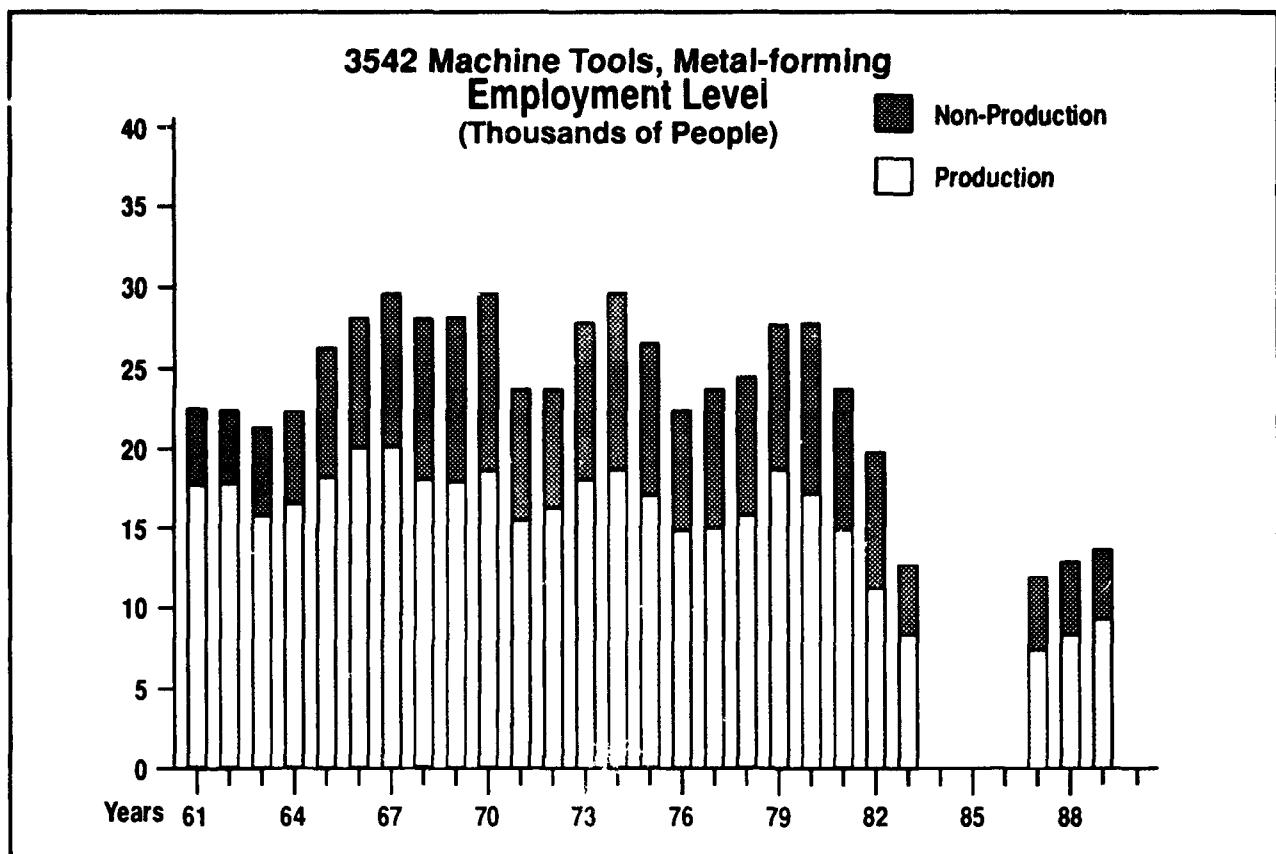


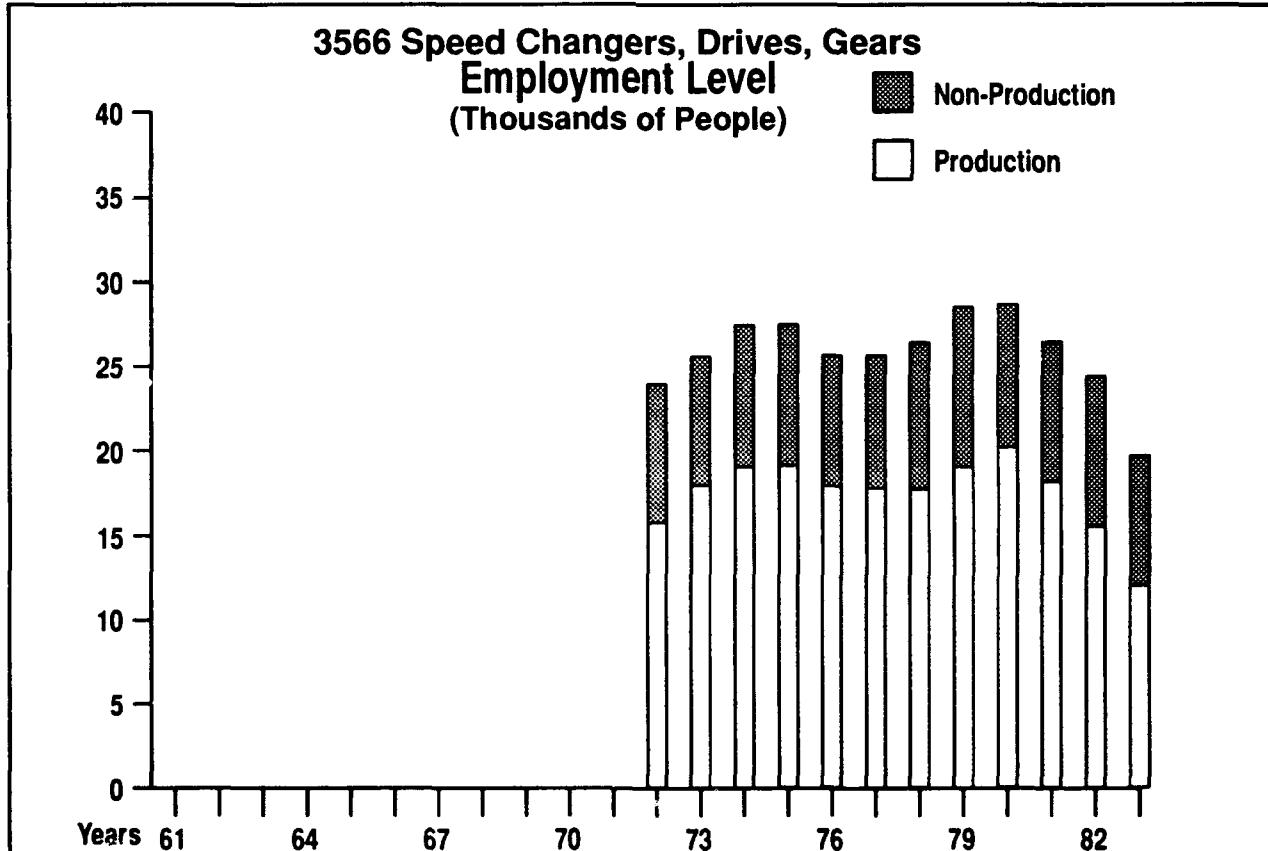
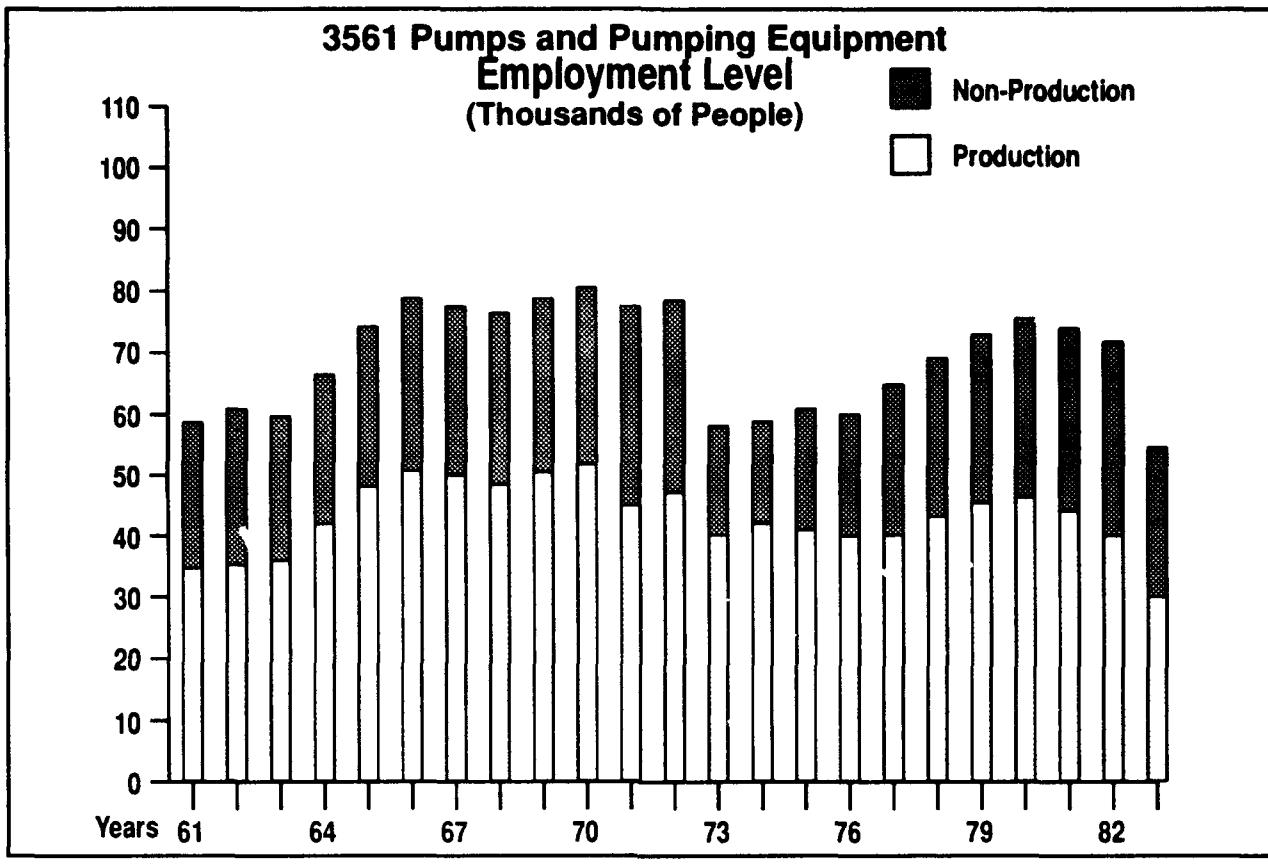
**3511 Turbines, Turbine Generator Sets
Employment Level
(Thousands of People)**



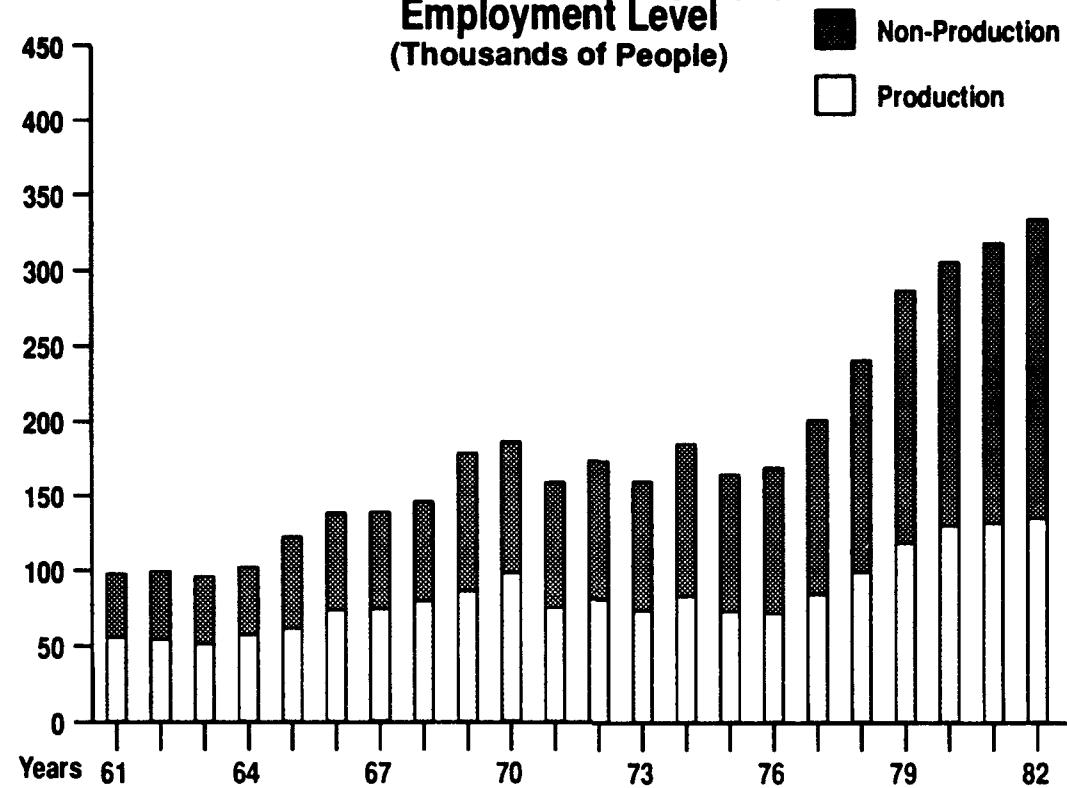
**3531 Construction Machinery
Employment Level
(Thousands of People)**



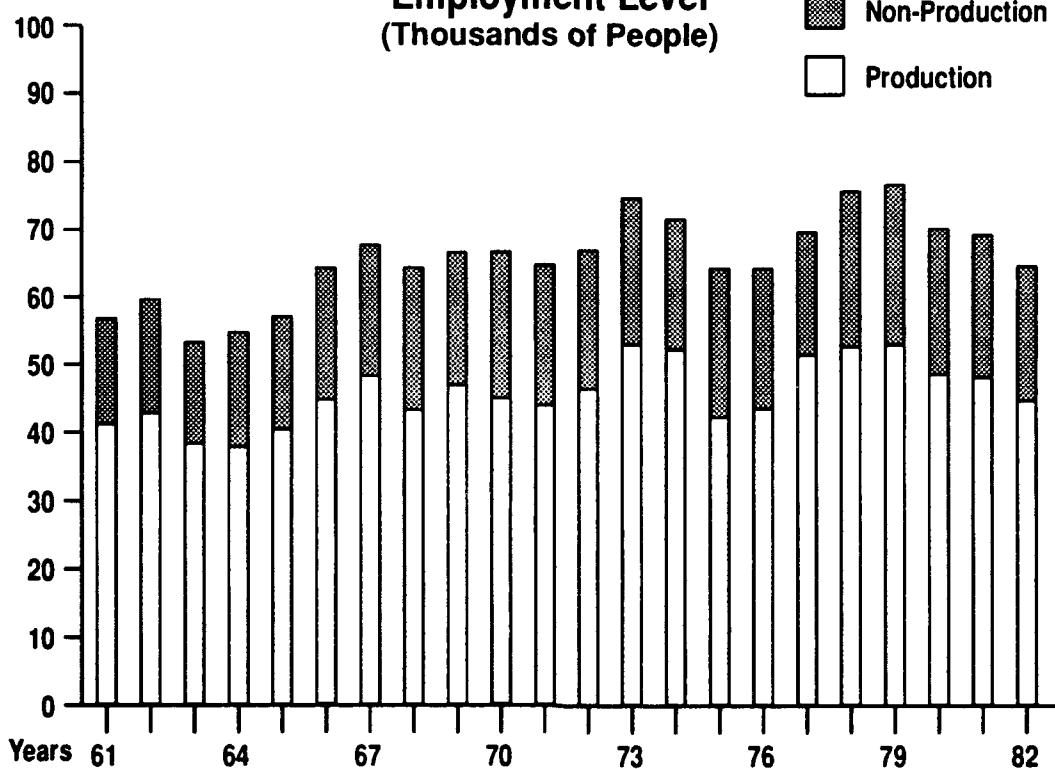


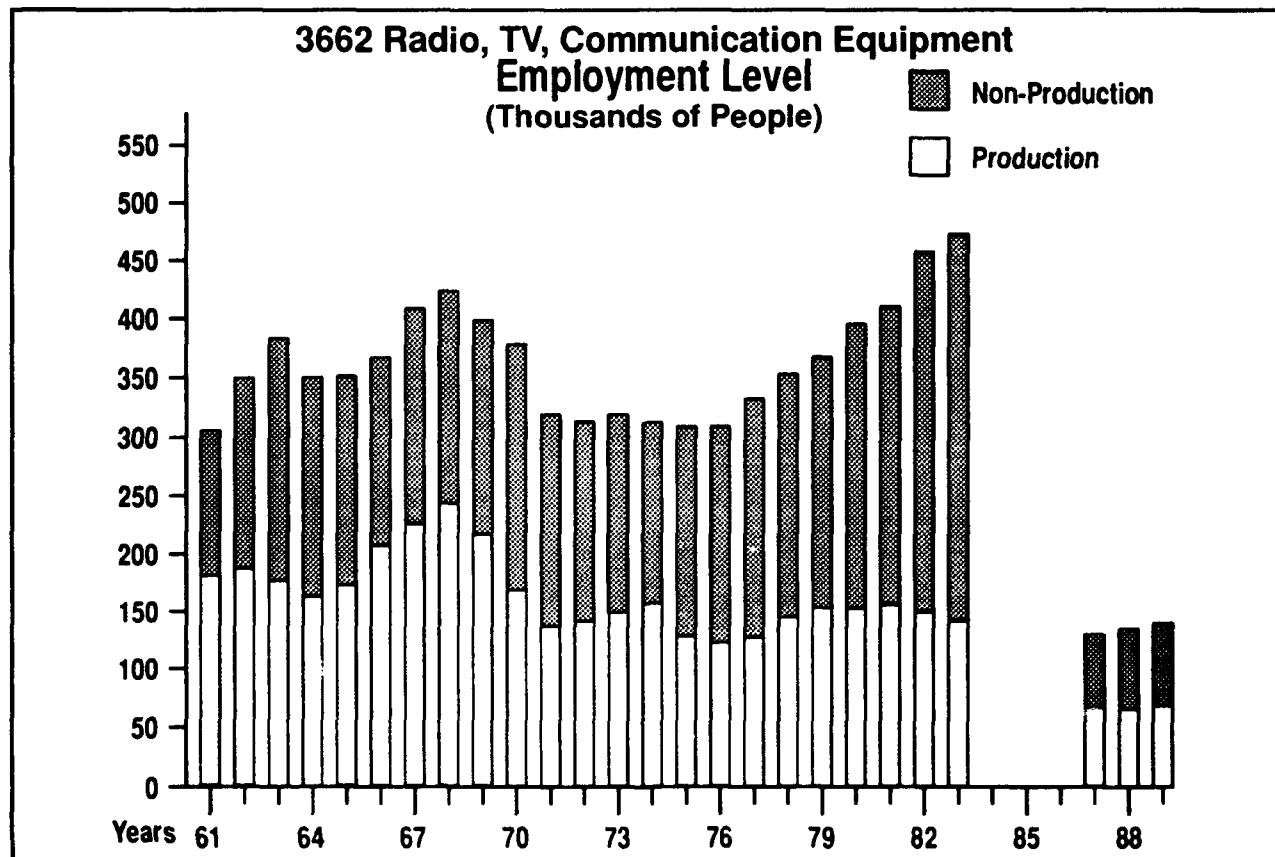
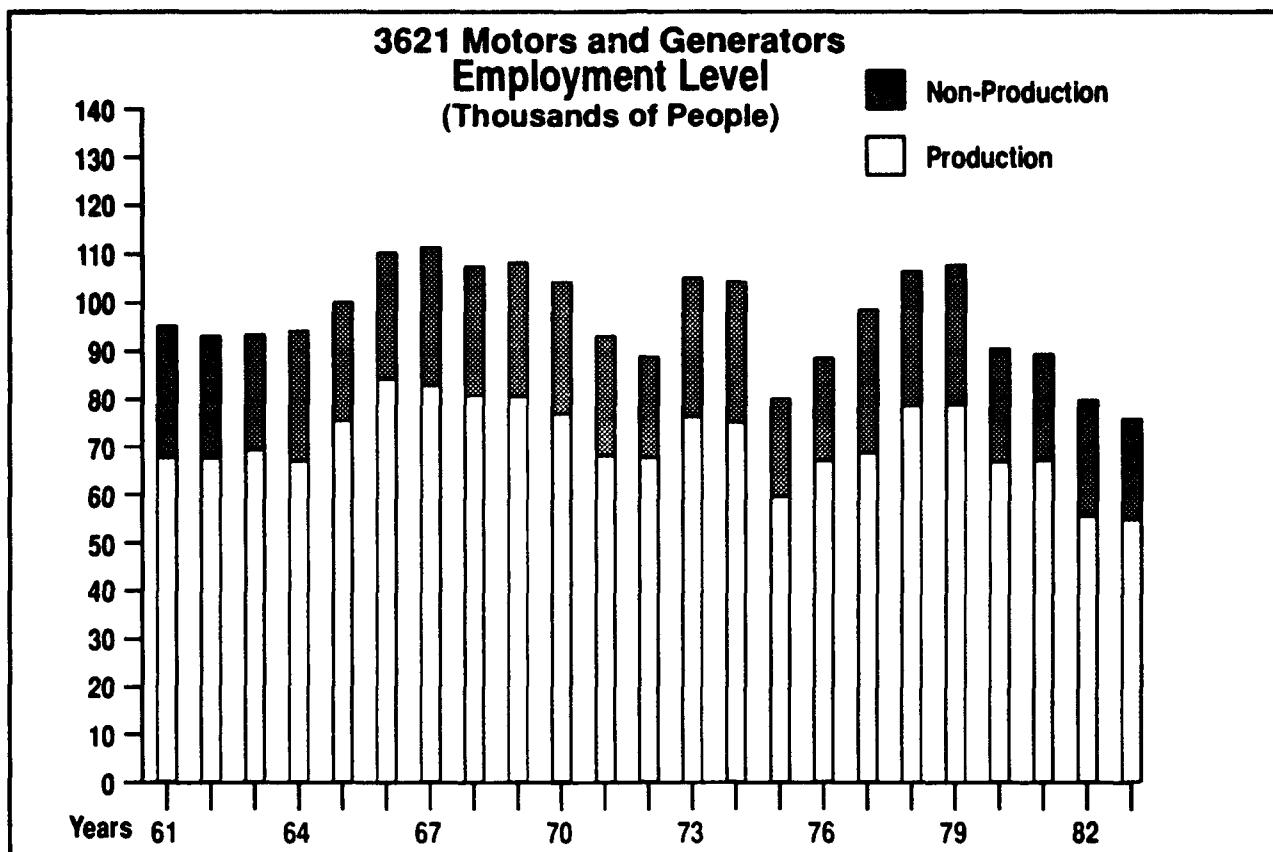


3573 Electronic Computing Equipment
Employment Level
(Thousands of People)



3613 Switchgear and Switchboard Apparatus
Employment Level
(Thousands of People)

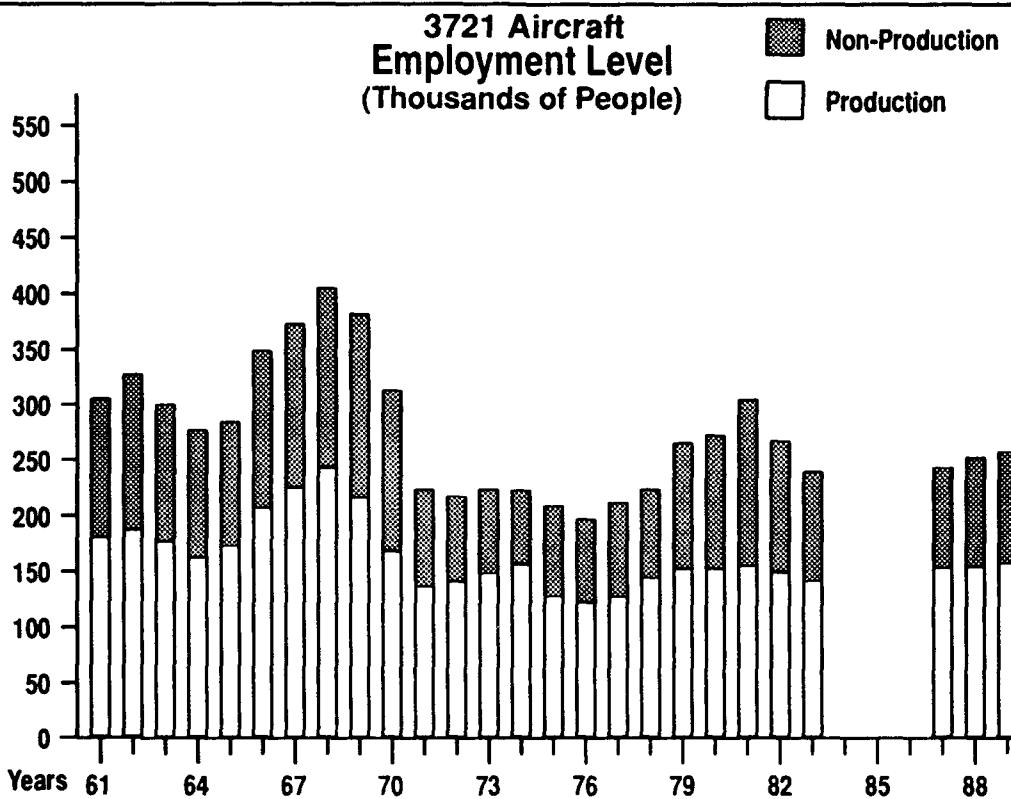


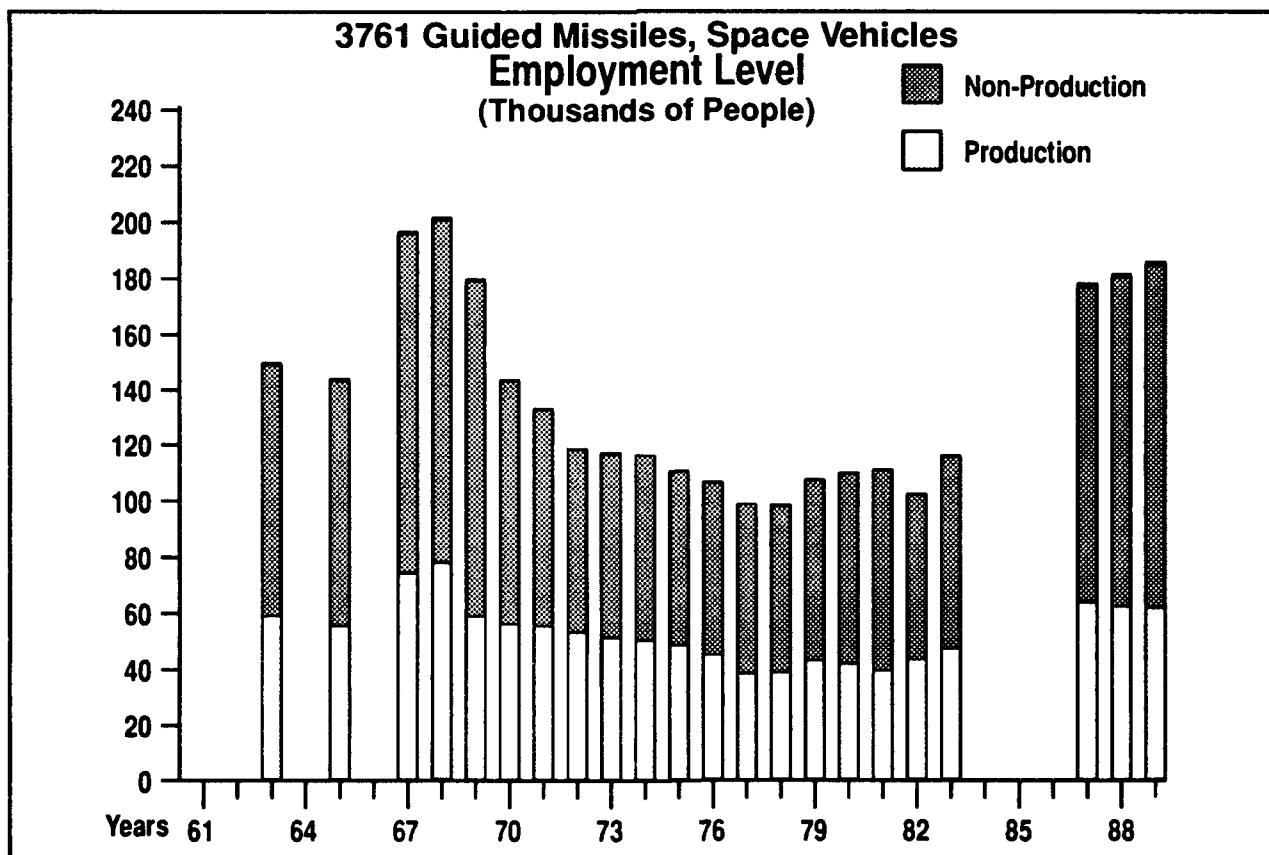
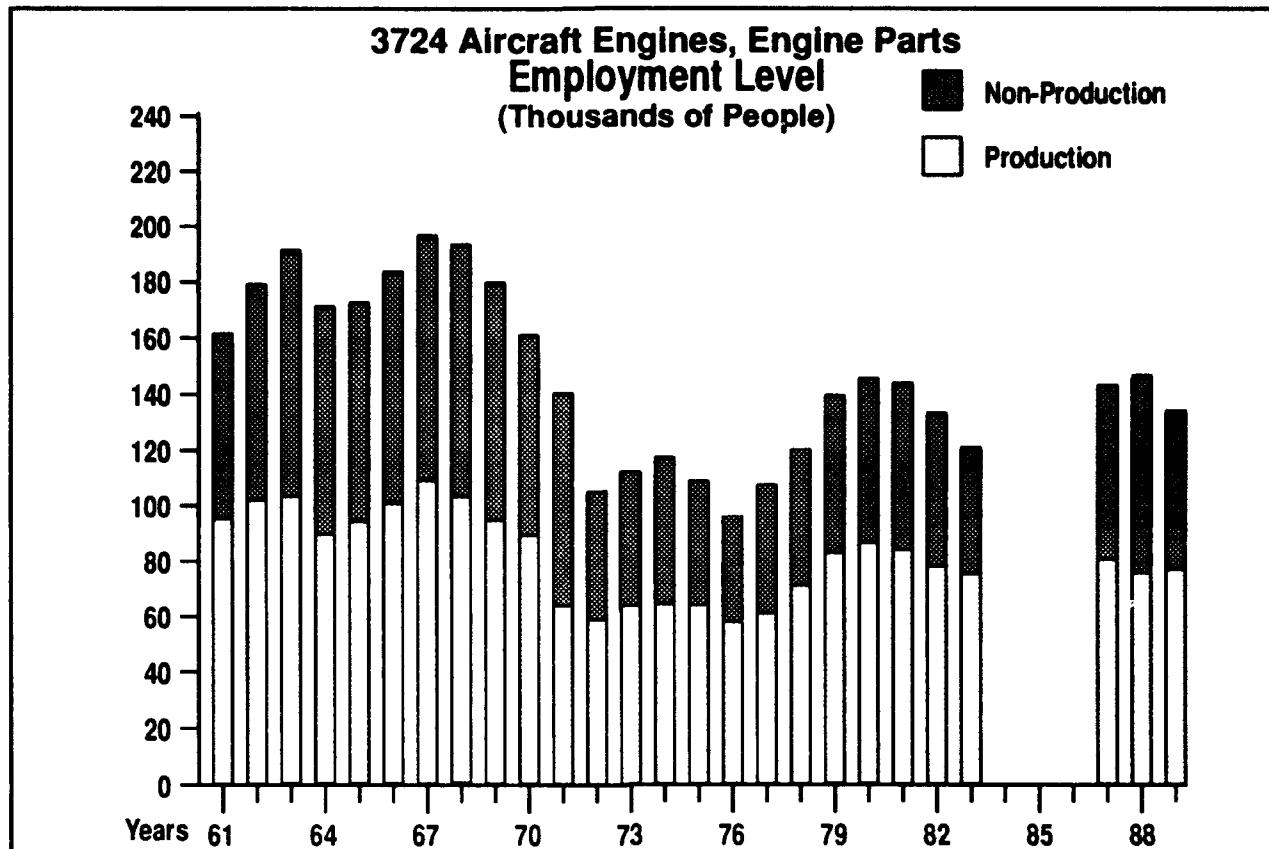


**3674 Semi-Conductors, Related Devices
Employment Level
(Thousands of People)**

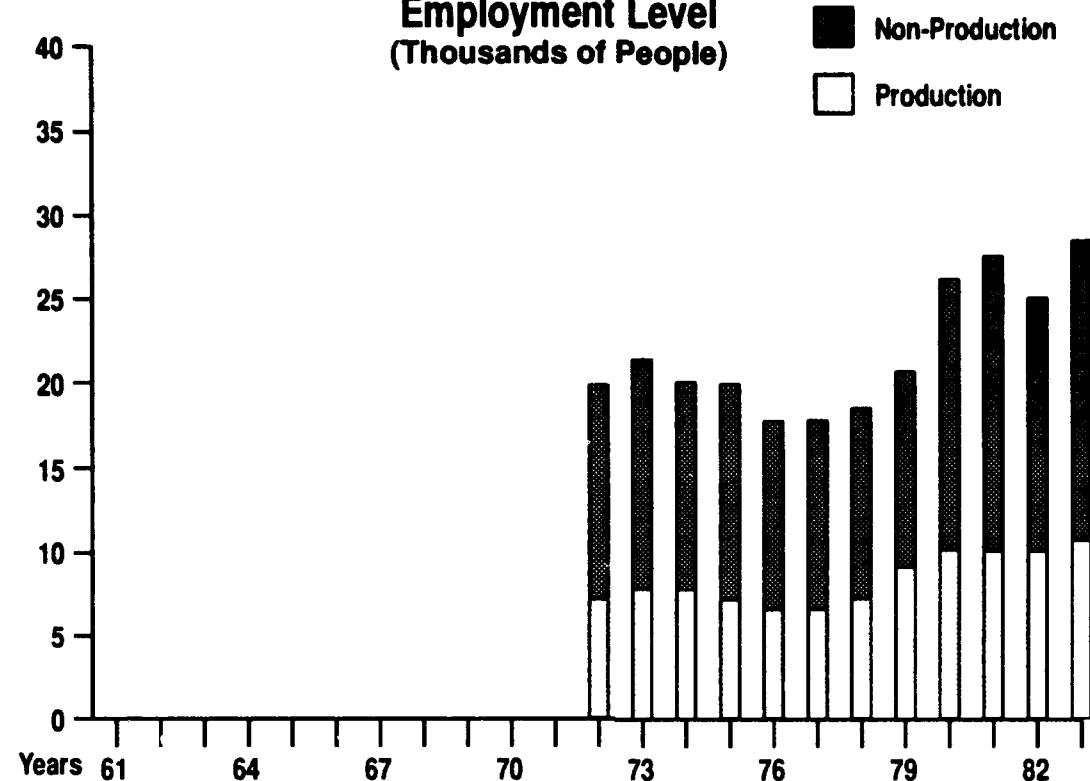


**3721 Aircraft
Employment Level
(Thousands of People)**

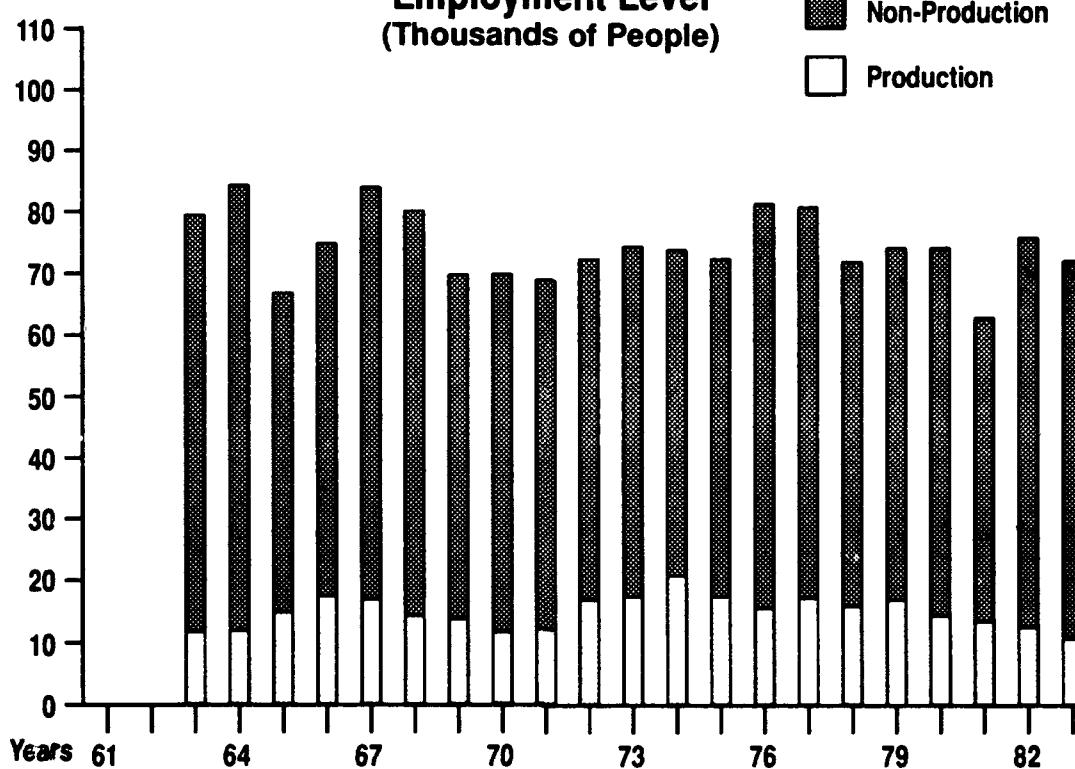




3764 Space Propulsion Units, Parts
Employment Level
(Thousands of People)



3795 Tanks and Tank Components
Employment Level
(Thousands of People)



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